European Commission

EEFIG

ENERGY EFFICIENCY

FINANCIAL INSTITUTIONS GROUP

Collecting and monitoring data on energy efficiency investments and financing across EU Member States and targeted economic sectors

Final Report

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The Energy Efficiency Financial Institutions Group (EEFIG) was established as a specialist expert working group by the European Commission and United Nations Environment Programme Finance Initiative (UNEP FI), in late 2013, as a result of the dialogue between Directorate-General for Energy (DG Energy) and UNEP FI, as both institutions were engaging with financial institutions to determine how to overcome the well documented challenges inherent to obtaining long-term financing for energy efficiency.

EEFIG's work is the consensus group effort of over 500 members whose current professional experience falls into one of the following stakeholder groups:

› Public and private financial institutions (banks, investors, insurers etc.);

› Industry representatives and industry associations;

› Banking associations and investor groups;

› Energy efficiency industry experts;

› Energy efficiency services representatives;

› SME associations and expert representatives;

› Civil society experts representing diverse energy efficiency stakeholder groups;

› International Energy Agency (IEA);

› European Commission; and

› UNEP FI.

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This report has been complied based upon the work of EEFIG Working Group (WG) whose full membership is listed below. We specifically thank Markus Seifert (lead), Peter Sweatman (co-lead), Armin Mayer, Dinne Hansen, Mark Hafner and Niklas Haller for their leadership of this WG's work.

Legal Disclaimer

ABBREVIATIONS

AI	Artificial Intelligence
BCBS	Basel Committee on Banking Supervision
DENEFF	Germany Industry Initiative for Energy Efficiency
EBA	European Banking Authority
EC	European Commission
EED	Energy Efficiency Directive
EEFIG	Energy Efficiency Financial Institutions Group
EIB	European Investment Bank
EIBIS	European Investment Bank Investment Survey
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificates
ESG	Environmental, social, and corporate governance
ESS	European Statistical System
FI	Financial institution
GHG	Greenhouse gas emissions
IEA	International Energy Agency
KPI	Key performance indicator
MS	Member State
NECP	National energy and climate plan
NEEAP	National energy efficiency action plan
SBS	Structural Business Statistics
SDG	Sustainable Development Goals
SME	Small and medium-sized enterprises
WG	Working Group

Executive Summary

Energy efficiency is a critical pillar of Europe's clean energy transition; without it, most EU countries are unlikely to achieve their climate commitments cost effectively and on time. Energy efficiency can only realise its full potential, however, with a **significant increase in investment** in efficient technologies, upgrades and systems across key economic sectors. In comparison with investments in conventional and renewable energy sources, the investment gap in energy efficiency in Europe is considerable.

One of the fundamental keys to unlock more energy efficiency investments is improved **data**. Investors, lenders and consumers alike need clearer and more reliable data on how energy efficiency investments perform in various settings. Good data gives confidence, reduces risks and helps to create the kind of investment scale that is needed to make energy efficiency investments the first choice for countries seeking to improve energy security and achieve net zero emissions.

This report provides a comprehensive examination of the current status of data on energy efficiency investments in the European Union (EU). It was developed during a two-year, iterative process by a Working Group of the Energy Efficiency Financial Institutions Group (EEFIG). The Working Group was comprised of **23 selected qualifying members from 18 institutions along with 41 expert observers**, and was tasked by the European Commission (EC) to conduct this work as part of wider EC efforts to improve the investment landscape for energy efficiency in the EU.

The report features:

- An **overview of 52 data sources** that provide insights into energy efficiency or specific energy investment data. These datasets cover primarily residential buildings, SMEs and industry sectors, which were identified as the main targets, however they extend across other activities.

- A review of the two main existing methods used to measure energy efficiency investments: **top-down**, involving aggregation and estimates/modelling, and **bottom-up**, relying on large volumes of empirical data.

- An in-depth examination of current **efforts** to track energy efficiency investments **by leading organisations**, including for example Eurostat, the European Investment Bank (EIB), the International Energy Agency (IEA), and Odyssee-Mure.

- A look at some **key innovations** in data collection and analysis based on web and machine learning or artificial intelligence (AI) applications, with examples from SkenData in Germany and Sociedad de Tasacion in Spain.

- An examination of **barriers and obstacles** to analysing multiple and disparate datasets, along with an example (EuroDat) of how to **resolve** these issues in order to create primary keys for data matching.

To assess and compare data quality for the datasets and approaches cited above, the Working Group drew on **12 principles used by the Basel Committee on Banking Supervision** (BCBS) for the sound aggregation of risk data in banks. While these principles were developed

in 2019 to deal with severe data-related shortcomings within financial institutions, the Working Group has adapted them for assessing energy efficiency investment data sources.

Using this framework, the Working Group was **unable to identify any single dataset that can immediately be adapted** for the purpose of measuring aggregate energy efficiency investments across Europe. However, the analysis did **identify several best practices which, by extension, can offer a roadmap** for the European Commission to work with Eurostat and Member States to establish a new framework to improve transparency on energy efficiency investments by sector.

Through the appropriate use of modelling, estimation, Artificial Intelligence (AI) and machine learning, the many gaps identified can be filled, and address some of the missing elements among the multiple datasets reviewed. The existing **IEA and EIB methods stand-out** for their multi-annual development and back-testing of different ways to use surveys and experts to hypothecate and bridge data gaps. Each of these approaches has benefitted from over seven years of continuous development.

Further, the Working Group identified a bright line between what is achievable in a **static "snapshot"** and what could be achieved through a **dynamic and well-resourced long-term approach** by Eurostat or similar agency empowered with an EU mandate to collect and monitor the relevant sectoral data over time. Finally, the Working Group provides consensus insights on the quality of the identified datasets.

The **conclusions of this report** can be summarized as follows:

- **Energy efficiency investment data will always provide a partial picture at national and EU-levels**: Even with perfect information on all financed energy efficiency transactions, many home renovations and corporate upgrades, which save energy are paid in cash, made with savings or operating cash flow. This means that reported financing, as a proxy for investments, will always be a partial dataset, and forms of extrapolation are fraught with difficulty.

- **A sectoral approach is required, as not all energy efficiency investments are equal**. There is little similarity between the costs per kWh of saving at home, at the office, in heavy industry or in a small company. While there are similar vectors, such as lighting, heating, air conditioning, and the time of use, the intensities are different and therefore the results are hard to extrapolate between sectors. Any energy efficiency investment data collection or estimation strategy needs to at least differentiate between residential and commercial buildings (by use) and business investments by NACE code (ideally) or at least separating energy intense industrial processes from the remainder.

- **National energy agencies, the IEA, the EIB and various Horizon 2020 projects have invested years in developing approaches to collect and estimate some energy efficiency investments**. While there is no "perfect" manner to collect all energy efficiency investment data, many organizations have been working independently to provide good quality estimates using partial datasets, high-level approximations and surveys. When assessed against the BCBS criteria, the Working Group believes that these approaches are useful building blocks for the EC strategy. As

part of the Working Groups results, the leading data sources were assessed against the BCBS criteria.

		BCBS criteria												
		Governance	Data and IT infrastructure	Accuracy and Integrity	Completeness	Timeliness	Adaptability	Accuracy	Comprehensiveness	Clarity and usefulness	Frequency	Distribution and accessibility	Review	**Overall assessment**
Data sources considered	EIB Investment Survey	3,2	3,0	3,3	3,5	3,3	3,3	3,2	3,0	3,3	3,3	2,6	3,3	3,2
	SkenData	2,5	3,8	3,0	2,8	4,0	3,8	2,8	2,8	3,8	3,8	2,3	1,8	3,1
	Sociedad de Tasacion	2,5	3,8	3,0	2,8	4,0	3,8	2,8	2,8	3,8	3,8	2,3	1,8	3,1
	Eurostat	3,5	3,4	3,0	2,9	2,6	2,0	3,1	2,7	2,8	2,6	3,6	3,5	3,0
	IEA	3,0	2,8	2,4	2,8	3,1	3,0	2,6	3,0	3,3	3,1	2,6	3,0	2,9
	Odyssee-Mure	2,9	3,0	2,7	2,9	2,9	2,3	3,1	2,7	3,1	2,7	2,6	3,2	2,8
	DEEP	3,0	3,4	3,2	2,6	2,4	2,8	3,0	2,4	2,8	2,4	3,0	3,0	2,8
	Operat	2,7	3,0	3,3	2,3	2,7	2,3	3,0	2,3	2,7	2,7	2,7	2,7	2,7

Table 1: Assessment of identified datasets by survey respondents. The colours indicate a positive (green), medium (amber) or less positive assessment (red) of how well these data sources would fit to the mission of the tracking investments into energy efficiency.

- **AI and machine learning are already being used by leading financial institutions to provide proxy energy efficiency data**. The Working Group identified two European companies offering energy efficiency data to financial institutions in three EU Member States and believes that these approaches will grow and extend to cover all EU27 Member States in the coming years. Back-tested error rates are reduced to levels comparable to "human error" by energy assessors, and in a world where all energy efficiency investment data is partial, the Working Group believes that these approaches have strong potential.

- **To provide improved transparency and inputs for EU policy making, EC energy efficiency investment data strategy should be a hybrid approach that levers the existing structures of Eurostat with Member States.** Merging best practices to build national data deriving energy efficiency investments using a "top-down" approach, calibrated by observing detailed asset-level bottom-up data emerged as a recommendation. Further, as AI and machine learning improves, these innovative approaches can be integrated over time and possibly merit a Horizon Europe call to align with EC and market needs.

This final report contains a description of the existing datasets identified by the Working Group and the Working Group's consensus assessment of each of them against a standard benchmark derived from the BCBS criteria (see Table 1). Using this assessment, a **suggested data strategy** has been developed alongside the above-mentioned detailed recommendations and conclusions.

In summary, the Working Group suggests a data strategy that takes into account the rapid development of the field on all levels, ranging from individual private sector initiatives to Member States as well as to the European Union and its bodies. An agile adaptation to the still evolving needs of the European Commission and other parties involved is key to an effective data strategy for investments into energy efficiency. The Working Group's **data strategy is threefold**:

1. **In the short-term**, and considering consistency of the result as key objectives, a survey-based data collection is the most flexible and timely approach for the European Commission to follow up. Also, in terms of costs and benefits, survey of a representative sample of European companies with a well-designed questionnaire is likely to provide the highest value in the short-term. The Working Group recommends to the European Commission to use such an approach as the next step in that evolving area of interest.

2. **In the medium-term**, and for starting the process of developing a long-term data collection methodology, which fits the needs of the European Commission for policy making, defining the organizational setup is critical: Which unit is going to be responsible for the new data collection? In which organization should this unit be anchored? Who are the most important stakeholders? This setup needs to be agile enough to take into account recent developments, for example the distortions in the energy market due to the Russian war against Ukraine, as well as changing needs on the side of the European Commission.

3. **In the long-term**, the dialogue with Eurostat needs to be established rather soon such that the requirements from the short and medium-term stage can be aligned with Eurostat's requirements and internal processes. Once the methodology, data requirements and governance structures have been finalized in medium-term stage, a legislative process needs to be initiated with the objective to finally make the new data requirements not only consistent but also enforceable across Members States.

The EEFIG consortium would like to take here the opportunity to thank all Working Group members and observers, who contributed to this work and provided their valuable input on various issues of relevance to this Working Group.

1 Introduction

Meeting the 2030 energy efficiency targets and their contribution to the 55% reduction in greenhouse gas (GHG) emissions by 2030 requires an estimated 165 billion EUR of investments into energy efficiency improving measures. Therefore, a significant step-up of energy efficiency financing – including multiple tools to trigger private investments – must be achieved. Additionally, the further uptake of energy efficiency financing products and the development of innovative financing schemes is key for achieving that goal. Last but not least, this report provides a data-led approach to support Article 28 of the recast Energy Efficiency Directive (EED) that provides a frame for Member States to expand Energy Efficiency National Funds and technical support.

The Commission needs better data on energy efficiency investments, in particular from the private sector, to ensure that 2030 energy and climate targets are met. Improved investment data can support improved public finance support and help identify and lever other resources to fill identified gaps as well as to ensure proper implementation of Article 28 of the EED recast.

Given these challenges, an EEFIG Working Group was established to provide guidance on the data issues that relate to energy efficiency investments and finance in Europe. This is the final report prepared in completion of the assignment entitled *Launch and facilitate the implementation of a new EEFIG Working Group on "Collecting and monitoring data on energy efficiency investments and financing across EU Member States and targeted economic sectors"* (EC request for services N° ENER/C3/FV2020-476/02/FWC2018-464/15 in the context of framework contract N° ENER/C3/2018-464).

The key objectives of the assignment are to:

- **Identify and assess the relevant datasets** to collect data and monitor energy efficiency investments and financing across EU Member States and in targeted economic sectors (residential buildings, SMEs, and industry); and assess the barriers and obstacles hindering the accessibility and interpretation of the identified datasets.

- **Develop and advise on the best method** to capture, process, and organize data on energy efficiency investments and financing over time and across EU Member States and targeted economic sectors, i.e. develop interfaces or data bases.

This report is structured as follows:

The **executive summary** preceding the introduction summarises the report including its conclusions and recommendations. This will be used as downloadable content on the EEFIG website and paraphrased to be included in the EEFIG newsletter.

Chapter 2 provides a brief presentation of the working methods and approach. A detailed composition of the Working Group is referenced in the appendix.

Chapter 3 maps and evaluates all the relevant identified datasets providing data and monitoring of energy efficiency investments and financing across EU Member States and in the targeted economic sectors: the **first sub-section** describes the two main approaches to data collection identified; the **second sub-section** reviews all the relevant identified datasets, which include IEA, EN-TRACK, EIBIS, DEEP, OPERAT, Odyssee-Mure, climate finance landscapes, SkenData, Sociedad de Tasación, Eurostat; and the **third sub-section** concludes the chapter by assessing the currently available datasets and expounds on their limitations.

Chapter 4 provides an overview of the issues faced in accessing and interpreting the data and assesses the possibility to address and overcome said barriers and obstacles to accessing and interpreting the data.

Chapter 5 provides the recommendations and conclusions of the Working Group together with the proposed methodology to capture, process, and organize data on energy efficiency investments and financing over time and across EU Member States.

The **Appendices** include a short paper summarizing the methodology the IEA uses to track global investment in energy efficiency (Appendix A); the collection of relevant literature stored in the Working Group's shared library (Appendix B); as well as the structure and approach of the Working Group (Appendix C).

2 Method and approach

This chapter describes the method and approach adopted by the EEFIG Working Group established to review the existing energy efficiency investment datasets in Europe and propose a strategy for the European Commission to gather the most appropriate information across Member States and target sectors.

EEFIG recruited for this Working Group financial institutions and relevant expert stakeholders to deliver on this data assignment. To address their objectives the Working Group contained a well-qualified team of data experts from diverse professional backgrounds that offer a 'top-down' and 'bottom-up' perspectives supported by subject matter experts from the EEFIG consortium. The Data **Working Group had 23 members from 18 institutions and 41 additional observers** (cf. 6Appendix C). The contribution of all members (during meetings, interviews, providing feedback, etc.) and the time invested in the Working Group's activities was fundamental to delivering the results and is highly appreciated by the Consortium and the European Commission.

Some institutions of importance (for example, but not limited to EBA or DENEFF) were interested in this work, however, were not able to contribute directly, and others did not meet the criteria for membership, therefore these institutions sent observers to the Working Group. Observers joined the Working Group meetings but do not actively contributed to its deliveries, although they were able to ask questions and receive drafts. Throughout the document, all reference to the Working Group and its tasks refers only to its members and not observers (unless stated otherwise). During all Working Group meetings, members, observers and external parties contributed to the discussions by presenting their company's results and work, thereby providing very helpful insights to the Working Group's mission. A full list of the presentations can be found in Appendix C.

Review of the Identified Datasets using WG Survey

During the process, the WG members and consortium identified **circa 50 datasets** from across Europe, either within Member States or at EU/International level. Chapter 3 contains a full review of these datasets.

In its second interim report, the consortium identified a **BCBS-data reliability framework assessment matrix** against which the core characteristics of financial data can be measured. This was adapted with input from the WG in order to cover energy efficiency investment datasets.

During all Working Group meetings, both members and observers contributed to the discussions and analysis.

Finally, a **survey** was created by the consortium for WG members to provide an assessment of the identified datasets against the adjusted **BCBS** criteria and provide inputs to the core issues raised in the WG terms of reference. The consensus results of the survey are summarised in this report, including the WG's assessment of each dataset. These conclusions were used by the consortium to provide the first draft of this report, which was then reviewed and edited by the WG. Together with inputs from the European Commission and reviewers, the final report was agreed and published.

3 Energy efficiency investment data in the EU – mapping and evaluation

The value and usefulness of any dataset for policy making can be defined by answers to two major questions:

1 Is the dataset designed with the **right purpose** in mind?

2 Does it contain data in **sufficient quantity and quality**?

Further the WG's assessments of existing data shows there are two general ways to build energy efficiency investment datasets: 1) From the **bottom-up** based upon observation of real transactions; and 2) From the **top-down** based upon approximations from the envelope of investment or energy or energy efficiency data.

The following sections discuss this problem and then review the existing identified datasets in this frame and against the BCBS criteria. Finally, we build a WG consensus assessment via the input from a **survey** which – together with Chapter 4 on barriers and obstacles – are the key ingredients driving the conclusions and recommendations of this report. A draft report was circulated to all WG members and comments were received during a significant review period.

3.1 Reconciling top-down and bottom-up approaches

To measure and monitor investments in energy efficiency, two general approaches are found: top-down and bottom-up approaches.

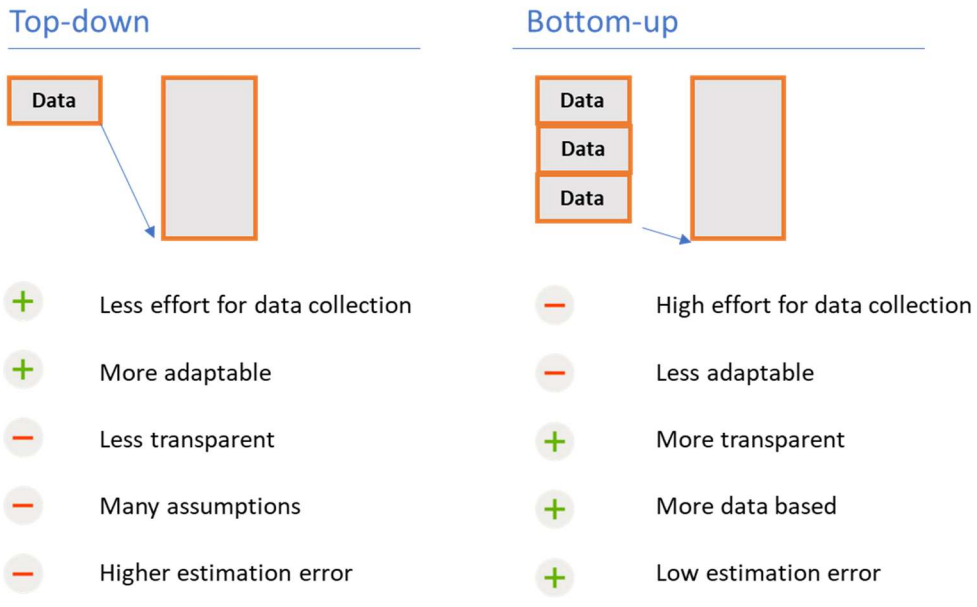


Figure 1 Overview of the approaches

Top-down approaches involve high-level data points which provide an estimate – after transformation – of the investments at a certain level of aggregation. Well-known examples include estimation methods used by the IEA or the EIB's industry and SME survey (EIBIS). Top-down approaches try to identify and use the best available data, be it a data sample collected by a survey, or a given set of data points reported by statistical agencies in Member States. Then, the investment numbers are estimated for the total population of companies or buildings across those Member States. For example: by collecting the number of heat pumps sold in a Member State, and using an assumption on the price and the energy typically saved by a heat-pump installation versus the median boiler, provides an estimate of the overall energy saved per Euro invested for that particular product category. If this exercise is repeated for all energy saving products in all Member States, the result is a pan-European estimate for all energy efficiency investments.

Top-down approaches typically involve global assumptions and scaling factors, which are used to perform an extrapolation. These methods are cost efficient as they avoid having to perform a very expensive full-scale data collection survey of the full population of companies or buildings. However, they are subject to estimation errors, in particular when they are not validated and scaled against true bottom-up data. They are also exposed to produce over-estimates of energy savings as multiple investments in the same property - when combined - save less energy in aggregate than each individually as the baseline changes per component implemented.

Bottom-up approaches in contrast, aim to build a comprehensive dataset comprising the desired information on a granular level and then sum these up to create the dataset. For example, a database can collect the data of all available projects involving energy efficiency measures in a sector or a geographical area and record their energy savings as well as their related investments. Then a simple sum provides the energy saved per Euro spent, and this can be extrapolated and used by policymakers across similar sectors or geographical areas. These are the approaches used to compile EU-wide databases like EEFIG's DEEP or EN-TRACK.

Bottom-up approaches are more precise in their results, when deployed properly. Utmost care needs to be taken to clearly define what kind of data is being collected and to find a procedure to perform the data collection in a homogenous manner across all Member States and industrial sectors. This requires stringent planning and execution. Such data collection is usually performed by the statistical agencies in the Member States or at European level by Eurostat.

Both approaches have their own strengths and weaknesses (see Figure 1) and are mutually beneficial. For example, top-down approaches can be calibrated based on bottom-up data, which has been collected in the same segments and geographical areas.

Beyond the intrinsic strengths and weaknesses of these approaches, both have additional merits resulting from the specific implementation of the approaches in

different contexts. To cover those additional aspects in our assessment of the available datasets, the WG uses a general framework to assess existing datasets, and to outline their individual strengths and shortcomings. Once all identified datasets are compared against the same standard, then conclusions as to how to combine them to deliver EU-level outcomes are considered.

3.1.1 Introduction to the framework assessing data collection and aggregation

To formalize the WG's approach to designing a data strategy for the European Commission, the WG identified a common frame of reference with 12 components for the assessment of data collection and aggregation. That frame is used to compare the available identified relevant datasets to see to which extent they cover the specific criteria relevant for the Commission.

Defining criteria for sound data collection and aggregation is not straightforward, especially when the data is imperfect, and the frame is complex and dynamic. Within the financial industry, there is just one common frame of reference for assessing the soundness of data flows within a financial institution provided by the **Basel Committee on Banking Supervision** (BCBS) in its paper number 239. BCBS 239 describes **12 principles for the sound aggregation of risk data in banks**. It was introduced after the financial crisis in 2009, because that crisis exposed severe data-related shortcomings within financial institutions. Due to its principle-based nature, this document describes a **set of best practices for data collection and aggregation**, which can be applied beyond the financial industry.

In the energy efficiency investment context, the comprehensive set of 12 principles can serve as a frame of reference for evaluating existing databases and defining what requirements the collection and monitoring of energy efficiency investment data should ideally fulfil.

The **12 principles** are listed below with the explanatory wording adapted to the needs of this Working Group's task, which is to provide a strategy for collecting and monitoring data on energy efficiency investments:

Principle 1 **Governance** – Energy efficiency investment data aggregation capabilities and reporting practices should be subject to strong governance.

Principle 2 **Data architecture and IT infrastructure** – One should design, build and maintain robust data architecture and IT infrastructure, which fully supports the data aggregation capabilities and reporting practices. These data architectures and IT infrastructure must be resilient in all market conditions and across different sectors.

Principle 3 **Accuracy and Integrity** – One should be able to generate accurate and reliable data to meet all reporting accuracy requirements. Data should be aggregated on a largely automated basis to minimize the probability of errors.

Principle 4 **Completeness** – One should be able to capture and aggregate all material energy efficiency investment data in the geographical areas and sectors targeted by that dataset. Data should be available at different levels: by asset type, industry, region, and other groupings, as defined for the specific task required.

Principle 5 **Timeliness** – One should be able to generate aggregate and up-to-date data in a timely manner while also meeting the principles relating to accuracy and integrity, completeness, and adaptability.

Principle 6 **Adaptability** – One should be able to generate aggregate data to meet a broad range of on-demand, ad hoc reporting requests, and requests due to changing needs can also be anticipated.

Principle 7 **Accuracy** - Energy efficiency investment reports should accurately and precisely convey aggregated data and reflect energy efficiency investments within a defined accuracy range. Reports should be reconciled and validated.

Principle 8 **Comprehensiveness** - Energy efficiency investment data should cover all material energy efficiency investments within the European Union. The depth and scope of these reports should be consistent with the size and complexity of a given sector, as well as the requirements of the database users.

Principle 9 **Clarity and usefulness** - Energy efficiency investment databases should communicate information in a clear and concise manner. Reports should be easy to understand yet comprehensive enough to facilitate informed decision-making.

Principle 10 **Frequency** – The data recipient (as appropriate) should set the frequency of energy efficiency investment report production and distribution. Frequency requirements should reflect the needs of the recipients, the nature of the sectors reported, and the speed at which these investments can change.

Principle 11 **Distribution and accessibility** – Aggregate energy efficiency investment data reports should be distributed to the relevant parties while ensuring confidentiality is maintained to the extent that the data is confidential at source.

Principle 12 **Review** – An independent party should periodically review and evaluate the data providers' compliance with the eleven principles above.

These principles do not specify how data is collected or aggregated, but define which requirements need to be fulfilled for it to be fit for purpose. The next section will show how these principles have been used to assess actual data collection strategies and methodologies.

3.1.2 Mapping of the identified datasets

One of the core challenges of tracking investments in energy efficiency is a near complete lack of relevant, coherent and EU-level data, which matches the 12 BCBS-adapted principles. More specifically, there is no uniform and centralized database with relatable and comparable information and economy-wide coverage.

Instead, data is dispersed across a multitude of sources, with important differences in the way in which datasets and databases are defined and constructed, and there are significant variations in data quality and quantity. As a result, **tracking efficiency investments requires the compilation and analysis of disparate datasets, often supplemented by modelling and estimates to generate a coherent picture**. This is the approach adopted globally by the IEA and is described in the below section 3.2.1 showing the IEA's methodology.

This section lists all WG-identified sources of data with direct data (e.g., actual building efficiency investments or projects data) or indirect data (e.g., modelled data or important complementary data) and that are relevant for tracking energy efficiency investments across the EU. The following section provides an **overview of the 15 data sources** the WG has identified along with a short description.[1]

1. **International organisations**: International organisations, notably the IEA and IRENA, compile or collect important energy efficiency investment data as well as providing key guidance or insights on methodological approaches.
2. **Ministries and government agencies**: Summary reports contain data - notably on grant and subsidy funding – and are examples of the kind of information on energy efficiency investments held by national ministries, yet coverage and quality varies significantly across different EU Member States.
3. **Energy agencies**: As key implementing bodies for energy efficiency measures and market support mechanisms, energy agencies should hold important energy efficiency investment data. This WG was unable to engage and review many of these datasets, but thinks that this is a strong area that the European Commission can develop through the Eurostat relationship.
4. **Multilaterals/IFIs/development banks**: As a core part of their mandates and business, multilateral institutions, IFIs and development banks are among the most important sources for energy efficiency investment data. Their country or regional specific investment programmes target specific sectors and have very detailed views of their investments in them.
5. **Lenders/FIs**: In principle, lenders and financial institutions should be a core source of energy efficiency investment data, however only a handful of these organisations seems to currently track or provide such data. It may also be that they have better quality private data but are unwilling to make it public for competitive reasons.

1 This list notably excludes statistical bodies and related official national statistical databases. These are pillars or potential pillars of any effort to track energy efficiency investments and merit separate analysis and engagement as part of the methodology development.

6. **Financial data providers**: Data from providers such as Bloomberg Terminal collect data from banks' financial statements, which recently include line items on "Attributable Lending to Energy Efficiency" and "Attributable Lending to Green Buildings". While only a handful of lenders provide such data, **policy makers might consider making such reporting mandatory.**
7. **Associations**: Sector and trade associations may track information directly or indirectly collecting the data related to energy efficiency investments as part of their members' services, to support advocacy, for example.
8. **NGOs/think tanks**: Much like associations, these organisations can play an important role in tracking and assessing energy efficiency investment data across sectors. Depending upon their mandates and funding these players can collect and assess datasets, except as a non-primary actor they need granted access.
9. **EU projects**: Several EU funded Research and Development (notably Horizon 2020) projects have collected, or are in the process of collecting, relevant data, from which some of the information is relevant to energy efficiency investments. Interestingly, most Horizon 2020 energy efficiency research projects identified and assessed by this WG reveal very little usable data. Of course, this is maybe because the collection and retaining of usable data was not a Key Performance Indicator under the project terms of reference.
10. **Research institutes and consultancies**: These organisations may conduct their own empirical data collection, provide important summaries and analyses of available data or develop commercial tools such as simulation software to support retrofits, for example. Also, when contracted as independent third parties, they can work with private data to draw out conclusions for company or public policies.
11. **Market research companies**: These are among the most important and valuable coherent sources of energy efficiency investment data, whereby payment is usually required to access granular datasets. Many aggregators, like IEA, also subscribe to these external datasets.
12. **Media**: In some cases, media organisations may provide energy efficiency investment data for articles or at least pertinent high-level analysis/coverage.
13. **Machine learning/AI**: Emerging and potentially critical tools are software-based tools that can 'trawl' and compile public information across the web or specific applications that compile identified dataset (e.g. Google Maps, Land Registries) that is directly or indirectly relevant for tracking energy efficiency investments. Two examples of these approaches were identified by the WG (SkenData and Sociedad de Tasación) and are described in more detail below.
14. **Regional, municipal (city) and local authorities**: These public bodies may hold significant data on energy efficiency collected through building retrofit programmes, for example, and they may also fund or sponsor

important convening organisations such as local/regional energy hubs or communities.

15. **The private sector**: Companies, notably major providers of energy efficient equipment (insulation, lighting, appliances, etc.) are an important source of information when it comes to investments in energy efficiency, however the sheer size of the sector and issues related to access (including privacy/proprietary issues) complicate data collection and analysis.

Table 2 below shows examples of datasets identified by the WG provided by some of the above sources where applicable or available, along with a basic description as well as its sector and geographical coverage. **It is important to emphasize that this table is not exhaustive**. Instead, it is designed to provide some relevant examples and can serve as a basis for developing a more comprehensive European Commission's data strategy as part of ongoing efforts not only within the EEFIG Data WG, but also as part of ongoing efforts by the European Commission to track energy efficiency investments.

As discussed, developing and maintaining a robust dataset as well as a data model should form an essential part of the European Commission's methodology. There is a diversity of data sources and formats, as is shown in Table 2 which means that tracking energy efficiency investments effectively will require a 'manual' effort and committed resource capacity (e.g., staffing). Several of the sources identified here require commercial and/or data sharing agreements that need to be negotiated, paid for and periodically renewed. The European Commission's data strategy for energy efficiency investments, therefore, is very likely to come with investment and resource requirements.

Table 2: Selected sources for tracking energy efficiency investments

Source	Name	Description	Sectors	Country
Ministries	Federal Ministry for Economic Affairs and Climate Action (BMWK)	Information from subsidy programmes including effinvest[2] (not compiled in public database)	Multiple	Germany
Ministries	Federal Ministry for Housing, Urban Development and Building (BMWSB)	Standardised database for ecological evaluations of buildings	Buildings	Germany
Ministries	Federal Office for Economic Affairs and Export Control (BAFA)	Information from subsidy programmes (not compiled in public database)	Multiple	Germany
Ministries	Ministry of Environment & Energy	Register of Energy Inspectors & Archive of Energy Inspections (buildingcert.gr)	Multiple	Greece

2 A one-stop-shop solution in Germany, a platform hosted by a fintech, involves 350 FI's and invites SME's to look for financing for energy efficiency projects.

Source	Name	Description	Sectors	Country
Ministries	Ministry of Economy and Development	Official website of the ministry contains a large database for grant funded projects across all sectors (ANAPTYXI.gov.gr)	Multiple	Greece
Ministries	National Housing Agency (Anah)	France Renov - public digital platform with resources related to building retrofits	Buildings	France
Ministries	Department for Levelling Up, Housing and Communities (DLUHC)	EPC Register containing nearly 500,000 EPCs across England and Wales	Buildings	UK
Financial Institutions	European Investment Bank (EIB)	See EIBIS survey detailed in report	Multiple	EU27
Financial Institutions	Germany Development Bank (KfW)	Extensive information on subsidy based retrofit programmes (not available in single public database)	Multiple	Germany, global
Financial Institutions	Hellenic Development Bank	Data on renovation programmes delivered as part of Covid recovery and other funding streams (database not public)	Multiple	Greece
Financial data providers	Bloomberg Terminal	This established platform for financial services also collects standard efficiency related lending indicators that banks could be mandated to report against	Multiple	Global
EU projects	SEAF – Standardisation of Sustainable Energy Asset Evaluation Framework	Linked to eQuad, contains information on ESCO projects (detailed info pending)	Multiple – ESCO projects	UK, France, Italy, Greece, Finland
EU projects	CRREM – Real estate, exploring the potential risk of 'stranded' investments	1,300 building assets	Buildings	EU27 (tbc)
EU projects	EN-TRACK – Performance-Tracking Platform for Investments in Buildings	4,500 buildings, ~1,000 projects	Buildings	EU 27 target but pilot data from Spain and Bulgaria
EU projects	Triple-A – Enhancing the Investment Value Chain of Energy Efficiency Projects	Information to be confirmed	Buildings	Bulgaria, Czech Republic, Germany, Greece, Italy, Lithuania, Spain and The

Source	Name	Description	Sectors	Country
				Netherlands
EU projects	QualitEE – Quality certification frameworks for energy efficiency services	28 pilot projects in 11 countries	Buildings and SMEs	Austria, Belgium, Bulgaria, Czech Republic, Germany, Greece, Latvia, Slovakia, Slovenia, Spain, and the UK.
EU projects	eEaaS – Efficient Equipment as a Service for SMEs	100 to 1000 data points (more info pending)	Buildings	Belgium, the Netherlands and Spain
EU projects	AmBIENCe	BPIE database and data from Belgian and Portuguese pilots	Buildings	Belgium, Portugal, Spain, Italy
Energy agencies	Austrian Energy Agency	The 'Monitoringstelle' contains data about implemented projects and related investments.	Buildings	Austria
Energy agencies	Germany Energy Agency (DENA)	Annual buildings report including investment figures, building rates, etc.	Buildings, others?	Germany
Energy agencies	Sustainable Energy Authority of Ireland (SEAI)	Database of energy research activities – currently investment info on 1 residential retrofit project	Multiple	Ireland
Energy agencies	French Energy Agency (ADEME) with support from Fraunhofer and Enerdata	ODYSSEE & MURE databases of indicators and impacts of implemented measures (see dedicated section in report)	Buildings	EU-27
Energy agencies	ADEME	OPERAT platform allows owners/developers seeking to comply with codes to benchmark their buildings (see dedicated section in report)	Buildings	France
Energy agencies	Italian Energy Agency (ENEA)	Data related to the Ecobonus subsidy scheme (not publicly available)	Buildings	Italy
Energy agencies	Hrvoje Požar Institute	Information and data contained in several publications (not compiled in central database)	Multiple	Croatia
Dedicated funds	National Energy Efficiency Funds (NEEFs)	Established according to Article 28 (9) of the EED recast, NEEFs are a potentially important source of investment data, whereby detailed data on funds dispersion and monitoring would be provided by national energy agencies (as per lines above)	Multiple	EU27
Associations	German Energy Efficiency	Variety of initiatives, publications, events and resources (not compiled in central database)	Multiple	Germany, global

Source	Name	Description	Sectors	Country
	Industry Federation (DENEFF)			
Associations	Initiative on Energy Efficient Mortgages (EMF-ECBC)	Maintains a knowledge hub with extensive resources and information (not compiled in central database)	Multiple	EU27
Associations	ECEEE	Leading EU association for energy efficiency - data contained across large number of publications and resources (not compiled in central database)	Multiple	EU27
Associations	Association for Environment Conscious Building (AECB)	Information on over 400 low energy projects (new builds and retrofits) on the Low Energy Buildings Database (LEBD)	Buildings	UK
NGOs/think tanks	Buildings Performance Institute Europe (BPIE)	Dataset of 2100 buildings (details tbc)	Buildings	EU27
International organisations	EC	EU Buildings Database (current and future content requires review)	Buildings	EU27
International organisations	EC	De-risk Energy Efficiency Platform (DEEP): open-source database for energy efficiency investments performance monitoring and benchmarking (see dedicated section in report)	Buildings	EU27
International organisations	EC	Cohesion policy, ELENA facility, etc.: extensive data from implementation of funding streams across multiple spending periods – review and assessment required to extract usable data	Multiple	EU27
International organisations	EC	EU MS Long Term Renovation Strategies (LTRS), compiled by EC, should contain information on building stocks across all EU MS	Buildings	EU27
International organisations	EC	EU MS Recovery and Resilience Plans (RRPs) should contain measures and information on building renovation efforts	Buildings	EU27
International organisations	EC	Clean energy competitiveness - progress reports containing data on growth trends in heat pumps, for example	Multiple	EU27
International organisations	IEA	Multiple databases across the agency to support energy efficiency and other energy sector analysis	Multiple	Global
International organisations	IRENA	Several databases related to renewable energy including financial commitments and investment trends – may be an interesting precedent in terms of data structuring, and some actual data may be relevant for tracking energy efficiency investments	Multiple	Global

Source	Name	Description	Sectors	Country
International organisations	SE4ALL	Country level historical data for access to electricity; share of renewable energy in total final energy and energy intensity rate of improvement – may be directly applicable to analysis or for framing, proxies and estimates	Mutliple	Global
Research institutes & consultancies	EC Joint Research Centre (JRC)	A variety of datasets are provided across numerous JRC resources and publications (however not compiled in a central database)	Multiple	EU27
Research institutes & consultancies	Fraunhofer Insitute	Extensive data and information across buildings and other energy systems (not necessarily compiled in a single database)	Multiple	EU27
Research institutes & consultancies	Institute for Housing and Environment (IWU)	Representative sample of 21 million non-residential buildings	Buildings	Germany
Research institutes & consultancies	CPI Global	Data underlying the Global climate finance landscapes	Multiple	Global
Research institutes & consultancies	IKEM	Data on projects (Latvia) and energy & investment maps (Czech Republic, Germany)	Multiple	Germany, select EU MS
Research institutes & consultancies	Energies Demain & Casba	Simulation tool for building renovations	Buildings	France
Research institutes & consultancies	Institute for Climate Economics (I4CE)	Range of analysis and publications including on climate finance with country case studies (e.g., climate finance landscape for retrofits in Poland)	Multiple	France, select EU MS
Research institutes & consultancies	CUES Foundation	Connector organisation / hub with access to researchers and institutes across Europe – currently running major data collection with Hypoport SE to create an inventory of 100K residential buildings.	Buildings	The Netherlands, select EU MS
Market research companies	Guidehouse (Navigant)	Multiple commercially available datasets including data on spending on energy efficiency products and related services	Multiple	EU27, global
Market research companies	BSRIA	Multiple commercially available datasets including data on heat pumps	Multiple	EU27, global
Media	Bloomberg New Energy Finance (BNEF)	Similar to the IEA, BNEF provides analysis and publications across the energy sector as well as a 'terminal' with subscription based data (not necessarily compiled in a single database)	Multiple	EU27, global
Media	Euractiv	Extensive potential source of information however not collated centrally in a database - requires engagement and collation	Multiple	EU27

3.2 Review of current data collection strategies and methodologies

In general, data can be collected in various ways with each having its own advantages and drawbacks. In this section, we outline the **most important classical data collection strategies: top-down approaches, surveys, and bottom-up approaches**. These strategies are explained using **the "best in class" examples** discussed in the Working Group meetings: **Eurostat, the IEA's top-down approach, the EIB's survey, and the bottom-up approach of various climate finance landscapes**.

3.2.1 Summary assessment of Eurostat energy efficiency investment data

To better appreciate the current state of energy efficiency data and related fields in Eurostat, the consortium has undertaken a review of the existing Eurostat data and its sourcing and categorisation:

Brief recap of the role of the European Statistical system and Eurostat

Eurostat's [3] task is to offer high quality statistics and data on the European Union (EU) and its Member States (MS). This is not a simple task as it requires for multiple stakeholders such as National Statistical Institutes and other MS authorities to synchronize efforts under the European Statistical System (ESS) partnership. These efforts also include data from Switzerland and the authorities entrusted with statistics of the European Economic Area (EEA).

Metadata, defined as "pieces of information that have some meaning in relation to another piece of information[4]", provides data summaries that are essential for systems to classify and label data, and thus enable users to access with a high degree of precision what they are searching for.

To help standardize the collection and sharing of data, a Statistical Data and Metadata eXchange (SDMX) was launched in 2002 by Eurostat and BIS, ECB, IMF, OECD, UN, and the World Bank. The purpose of SDMX is "to manage and automate the process of data and metadata exchange". In 2009, a set of SDMX Content-oriented Guidelines were published to upgrade Eurostat and ESS metadata systems, as these were previously not fully SDMX compliant. Examples include the use of different reference metadata structures, and the use of metadata structures that were not harmonised[5].

3 Statistical Office of the European Union

4 UNC University Libraries. (2021). Metadata for Data Management: A Tutorial. [Website]. Retrieved from https://guides.lib.unc.edu/metadata/definition

5 Eurostat. (2021). SDMX The basis for renovating the ESS Metadata Systems. [Presentation].Retrieved from https://www.oecd.org/sdd/47624538.pdf

Eurostat holds **data on energy consumption for buildings, industry, and transport** under "Energy balances[6]" within the Euro SDMX Metadata Structure (ESMS). Data collection takes place on an annual basis and classifies the economic activities for surveys and the presentation of results following NACE Rev.2[7]**.** NACE codes revision 2 is the latest revised version of NACE codes that seeks to reflect technological developments and modernise statistics. As reference, the NACE classification is revised every 15 years, and the next revised version is expected to be in place in 2024[8].

The most recent EU "Energy balance" available[9] has sector-level energy consumption figures for 2020. **Eurostat receives disaggregated data, whose accuracy depends on the quality of the different national statistical systems, which may vary among the different MS**. According to Eurostat, "indirect indicators suggest overall accuracy of energy balance ought to be in general high", and it has not conducted a quantitative assessment of accuracy.

Over the years, ESS[10] has sought to move towards more harmonized validation activities, and the data for the current "Energy balance" has been checked with the MS for consistency for completeness checks, the consistency of time series, outliers, the efficiency of energy transformation processes, the checks on utilization factors, the energy transformation efficiency checks and the levels 0-3 of the ESS.VIP on validation[11]. According to Eurostat, validation on levels 4 (Consistency between separate domains available in the same organisation) and 5 (Consistency with data available in other organisations) was not performed consistently.

Published in 2017, the latest Quality report of European Union energy statistics[12] puts among its recommendations for MS that MS need to increasingly align their revision policies with the EU's, and to move towards an improved quantitative evaluation of the accuracy of the main balance aggregates.

Disaggregated data for energy use by Industrial sector by NACE code for each Member State

The following tables show examples of the current Eurostat datasets, including the subsectors within the industry sector:

6 Eurostat. (2021). Energy balances (nrg_bal). [Website]. Retrieved from https://ec.europa.eu/eurostat/cache/metadata/en/nrg_bal_esms.htm

7 European Union. (2006). OJ L 393, 30.12.2006, p.1. [Website]. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1407855715400&uri=CELEX:02006R1893-20080429

8 Statistics Netherlands (CBS). (2021). Changing and adding codes to the NACE classification. [Website]. Retrieved from https://www.cbs.nl/en-gb/longread/diversen/2021/adding-bio-based-products-and-materials-to-statistical-classifications/4-changing-and-adding-codes-to-the-nace-classification

9 Eurostat. (2022). Final energy consumption by sector (ten00124). [Website]. Retrieved from https://ec.europa.eu/eurostat/databrowser/view/ten00124/default/table?lang=en

10 Eurostat. (2021). Data Validation. [Website]. Retrieved from https://ec.europa.eu/eurostat/web/main/data/data-validation

11 European Union. (2021). CROS: Validation levels. [Website].Retrieved from https://ec.europa.eu/eurostat/cros/content/validation-levels_en

12 European Commission. (2021). Quality report of European Union energy statistics. Retrieved from https://ec.europa.eu/eurostat/documents/38154/4956233/Quality_report_EU_energy_statistics-2017_edition.pdf/0ec98467-7d02-4d2e-9c6c-ddbf50dea672

	NACE CODE
Iron and steel	C24
Chemical and petrochemical	C20
Non-ferrous metals	C24.4
Non-metallic minerals	C23
Mining and quarrying	B
Food, beverages and tobacco	C12
Textile and leather	C13, C15
Paper, pulp and print	C17
Transport equipment	C30
Machinery	C28
Wood and wood products	C16
Construction	C23.3.2 -
Other industry	B, C, D and E

Table 3: Subsectors of the industry code

Eurostat provides disaggregated data for energy use by industry covering the energy consumption of the NACE divisions[13]. This dataset's metadata structure falls under "Energy Balances" detailed above.

		Mtoe (unless otherwise specified)	EU27_2020	BE	BG	CZ	DK	DE
230	230	by Sector						
231	231	Industry	239.05	10.32	2.67	6.61	2.28	55.71
232	232	Iron and steel	24.84	1.03	0.12	0.91	0.09	7.12
233	233	Chemical and petrochemical	50.78	3.99	0.79	1.04	0.27	13.56
234	234	Non-ferrous metals	9.56	0.30	0.21	0.09	0.00	2.26
235	235	Non-metallic minerals	33.06	1.30	0.56	1.16	0.50	6.73
236	236	Mining and quarrying	3.64	0.05	0.11	0.08	0.08	0.35
237	237	Food, beverages and tobacco	27.40	1.64	0.24	0.56	0.59	5.10
238	238	Textile and leather	3.67	0.17	0.06	0.12	0.02	0.41
239	239	Paper, pulp and print	32.23	0.65	0.21	0.68	0.06	5.35
240	240	Transport equipment	7.45	0.12	0.02	0.52	0.01	2.87

Contents | EU27_2020 | BE | BG | CZ | DK | DE | IE | EE | EL | ES | FR | HR | IT | ...

Figure 2: Example of disaggregated data for energy use

Energy use by NACE code sector

Eurostat provides dataset "Energy supply and use by NACE Rev. 2 activity[14]". Selected activities include: manufacturing, electricity, gas, steam and air conditioning supply, and construction. According to Eurostat, the dataset is complete for 2014 and 2019, yet due to confidentiality of data[15], there are certain gaps. Eurostat also states that as a result of the accounting framework, the data's "internal coherence is very high".

13 Eurostat. (2021). Final energy consumption in industry by type of fuel. [Website]. Retrieved from https://ec.europa.eu/eurostat/databrowser/view/TEN00129/default/table

14 Eurostat. (2021). Energy supply and use by NACE Rev. 2 activity. [Dataset]. Retrieved from https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ac_pefasu&lang=en

15 Eurostat. (2021). Physical energy flow accounts (env_pefa). [Website]. Retrieved from https://ec.europa.eu/eurostat/cache/metadata/en/env_pefa_esms.htm

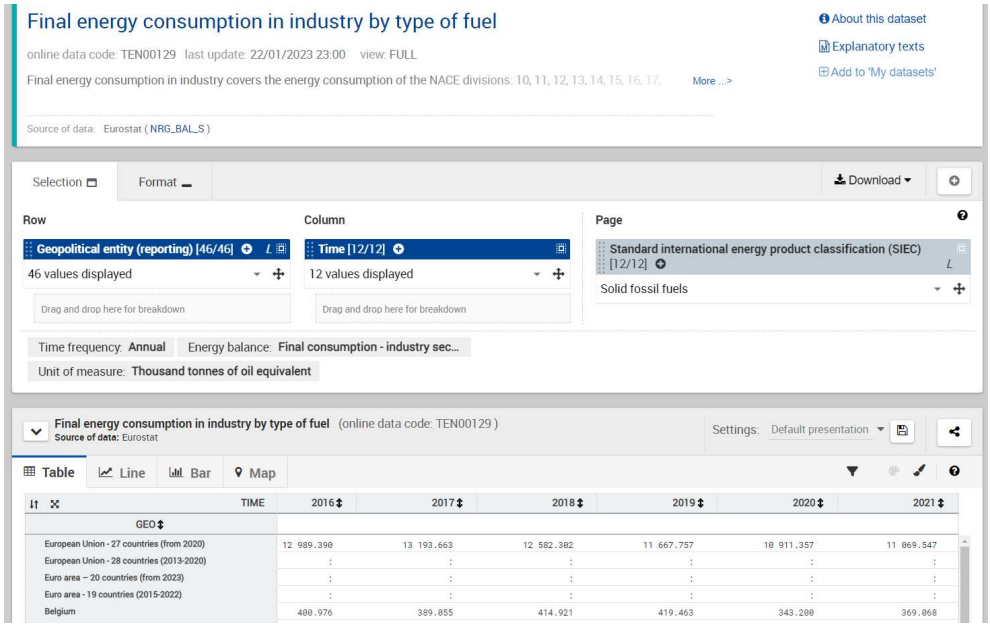


Figure 3: Example of energy use per NACE sector

Energy efficiency

Eurostat provides data for energy efficiency[16], measuring the level of energy consumption and distance to 2020/2030 targets[17]. The narrative behind these datasets is to answer the following questions:

- What is the progress on EU level towards Europe 2020 target for energy efficiency?
- What is the progress on EU level towards Europe 2030 target for energy efficiency?
- What is the development on national level towards objectives defined in Directive 2012/27/EU on energy efficiency?

The dataset covers all major sectors of the economy[18], whereby its accuracy is directly connected to the quality of MS statistical system. Eurostat has not performed a quantitative assessment of accuracy, yet a revision policy exists. We note that the **data provided by Eurostat is not broken down by sectors**. **Sectoral data on energy efficiency is provided by the European Environment Agency** (EEA[19]) "under Energy Efficiency index (ODEX) for final consumers in the EU". The EEA's data on energy efficiency is **sourced from the H2020 supported Odyssee-Mure[20] project**. Other selected key data categories include: "Energy consumption by end use per dwelling", "The effect of

16 Eurostat. (2021). Data browser: Energy efficiency. [Website]. Retrieved from https://ec.europa.eu/eurostat/databrowser/view/nrg_ind_eff/default/table?lang=en

17 Eurostat. (2021). Energy efficiency (nrg_ind_eff). [Website]. Retrieved from https://ec.europa.eu/eurostat/cache/metadata/en/nrg_ind_eff_esms.htm

18 Production, trade, energy transformation or energy consumption (e.g. energy sector, industrial sector, transport, commercial and public services, agricultural/forestry/fishing and households, for annual data).

19 EEA. (2021). Progress on energy efficiency in Europe. [Website]. https://www.eea.europa.eu/data-and-maps/indicators/progress-on-energy-efficiency-in-europe-3/assessment

20 ODYSSEE-MURE. (2021). Project Overview. [Website]. Retrieved from https://www.odyssee-mure.eu/project.html

building codes in the EU", and "Drivers of change in annual average energy consumption per household".

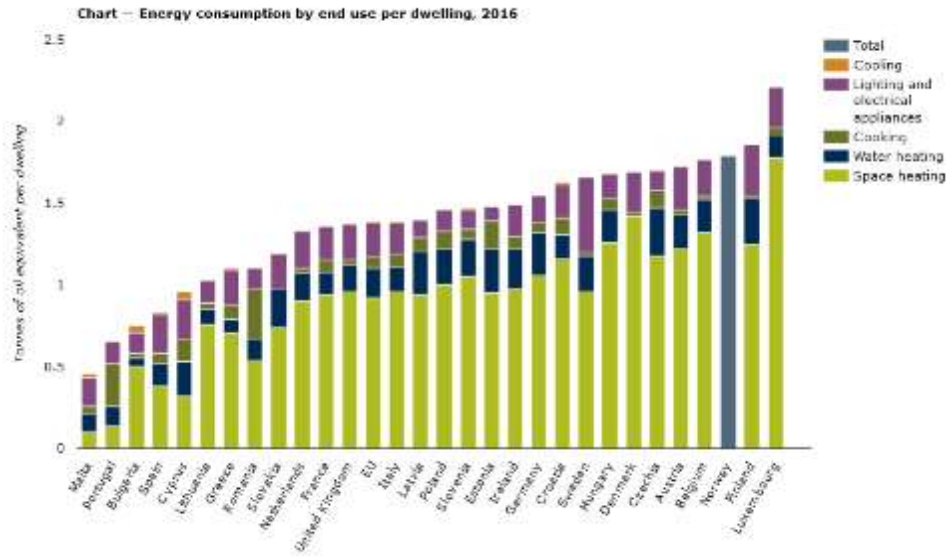


Figure 4: Energy consumption by end use per dwelling in 2016

Energy investments

Eurostat's Sustainable Development Goal (SDG) 7 'affordable and clean energy' dataset[21] landing page mentions the promotion of "investments in energy infrastructure and clean energy technology", yet the data clusters do not offer figures on investments. Dataset "Environmental protection investments of total economy[22]" presents investments of the total economy (corporations and governments) to deliver environmental protection services (e.g. waste and wastewater management). It also states that "[i]nvestments undertaken by corporations to manage their own environmental pressures are included", however there is no indication and metadata available showing corporations are carrying out energy investments.

Interestingly, there is a link to the EIB Investment Survey (EIBIS[23]), which provides information on energy investments. Although directed at firms, its latest edition included a survey module for NUTS 2[24] municipalities[25], which focused on infrastructure investment needs of municipalities. Interestingly, when weighting for each group sample, the report's methodology followed the same

21 Eurostat. SDG 7 'affordable and clean energy'. [Dataset]. (2021). Retrieved from https://ec.europa.eu/eurostat/web/sdi/affordable-and-clean-energy

22 Eurostat. (2021). Environmental protection investments of total economy. Retrieved from https://ec.europa.eu/eurostat/databrowser/view/ten00136/default/table?lang=en

23 EIB. (2021). EIB Investment Survey 2021 - EU overview. [Website]. Retrieved from https://www.eib.org/en/publications/econ-eibis-2021-eu.htm

24 NUTS 2: basic regions for the application of regional policies

25 Ipsos MORI. (2020). EIB Group Survey of Investment and Investment Finance. Retrieved from https://www.eib.org/attachments/eibis-methodology-report-en.pdf

approach, of calibrating the samples to Eurostat Structural Business Statistics (SBS) population data on the size/sector categories within EU-27 MS and UK.

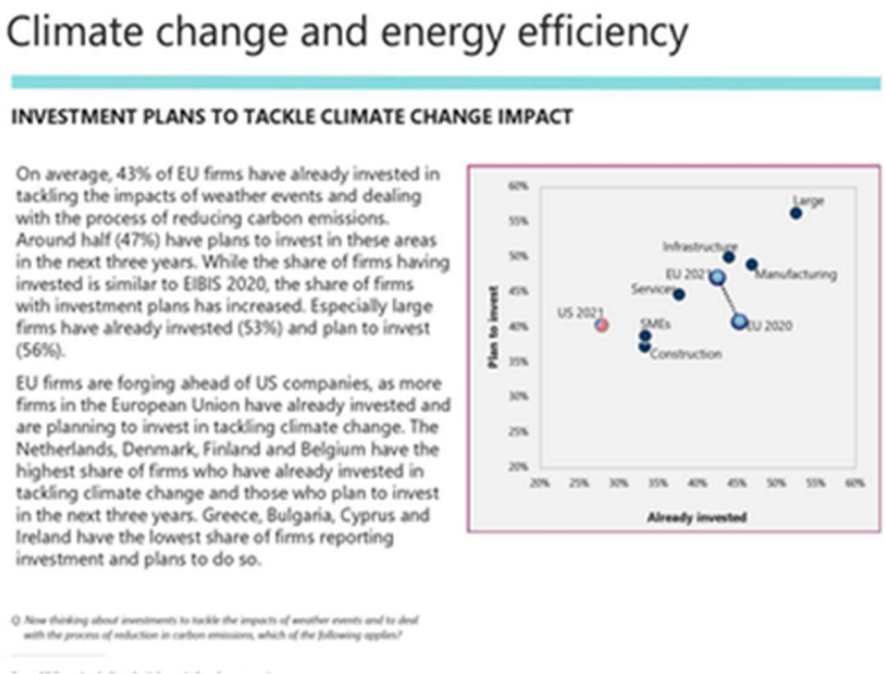


Figure 5: Investment plans to tackle climate change impact

Eurostat provides a wealth of data, which serves as a basis for many derived data products, as outlined in the next two sections.

Small and medium-sized enterprises (SMEs)

Eurostat offers data for SMEs in terms of number of enterprises, turnover, value added, and employment, yet no data related to energy is available. However, this lack of data could be remedied by the LEAP 4 SME,[26] which is an EU funded project carried out by the Austrian Energy Agency (AEA) to conduct data collection, analysis and methodologies for estimating the energy consumption of SMEs at the MS level. In its research, LEAP 4 SME highlights that it could not identify a "universal data source on energy data for SMEs", and it relied on the Eurostat's structural business statistics database[27] (SBS), Eurostat's physical energy flow accounts[28] (PEFA), and desktop research on MS.

26 LEAP 4 SME. (2021). Mapping SMEs in Europe. Retrieved from https://leap4sme.eu/wp-content/uploads/2021/07/LEAP4SME-D2.1-SME-energy-and-economic-mapping-in-Europe.pdf

27 Eurostat. (2021). Structural Business Statistics — Overview. [Website]. Retrieved from https://ec.europa.eu/eurostat/web/structural-business-statistics

28 Eurostat. (2021). Physical energy flow accounts (env_pefa). [Website]. Retrieved from https://ec.europa.eu/eurostat/cache/metadata/en/env_pefa_esms.htm

Table 13 Results of individual calculations and estimations of SME energy consumption and energy intensity per project partner country

Country	Estimated SME energy consumption [GWh]	Gross inland consumption [GWh]	Share in GIC	SME energy consumption of total business economy [GWh]	Energy intensity [MWh/mne]	Year	Notes
AT	63,199	404,698	16%	-	540	2017	Approach 2
AT	65,972	404,698	16%	-	564	2017	Approach 1
HR	18,535	100,916	18%	-	1,206	2018	Approach 1
EL	50,017	277,077	18%	50,017	1,534	2018	Approach 2
IT	496,798	1,855,132	27%	-	1,063	2017	Approach 2
IT	529,246	1,855,132	29%	-	1,132	2017	Approach 2
IT	235,438	1,825,789	13%	-	486	2018	Approach 1
IT	361,506	1,825,789	20%	-	746	2018	Approach 1
IT	326,816	1,825,789	18%	-	674	2018	Approach 1
IT	453,651	1,825,789	25%	-	937	2018	Approach 1
MT	1,469	8,814	17%	1,121	277	2015	Individual Approach
MT	1,439	8,814	16%	-	-	2015	Approach 2
PL	178,049	1,241,898	14%	-	1,407	2018	Approach 1
PL	120,345	1,241,898	10%	-	951	2018	Individual Approach
PT	27,122	286,668	9%	21,804	383	2017	Individual Approach
SK	19,703	200,592	10%	-	942	2017	Approach 1
SK	26,280	200,592	13%	-	1,257	2017	Approach 1
UK	221,150	2,153,142	10%	-	345	2018	Approach 1

Table 4: SME energy consumption and energy intensity per country

Buildings energy use by segment

Segmented building energy use is not available through Eurostat directly, however, Eurostat provides base data for the EU Building Stock Observatory[29] (BSO). EU Building Stock Observatory data is sourced from Eurostat, the JRC, EU funded projects, data available from MS national sources, and industry associations[30].

In more detail, the data categories include: Building stock characteristics, Building shell performance, Technical building systems, Nearly zero-energy buildings, Building renovation, Energy consumption, Certification, Financing, Energy poverty, and Energy market.

29 European Commission. (2021). EU Building Stock Observatory. [Website]. Retrieved from https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/eu-bso_en

30 European Commission. (2017). Support for setting up an observatory of the building stock and related policies. Retrieved from https://ec.europa.eu/energy/sites/default/files/documents/support_for_setting_up_an_observatory_of_the_building_stock_and_related_policies.pdf

All categories have subsequent clusters of data. For instance, Nearly zero-energy buildings includes data under: Number, Share, Floor area, and Energy Performance. Nevertheless, the data provided, unlike Eurostat's, not all data categories are populated. An example is shown below:

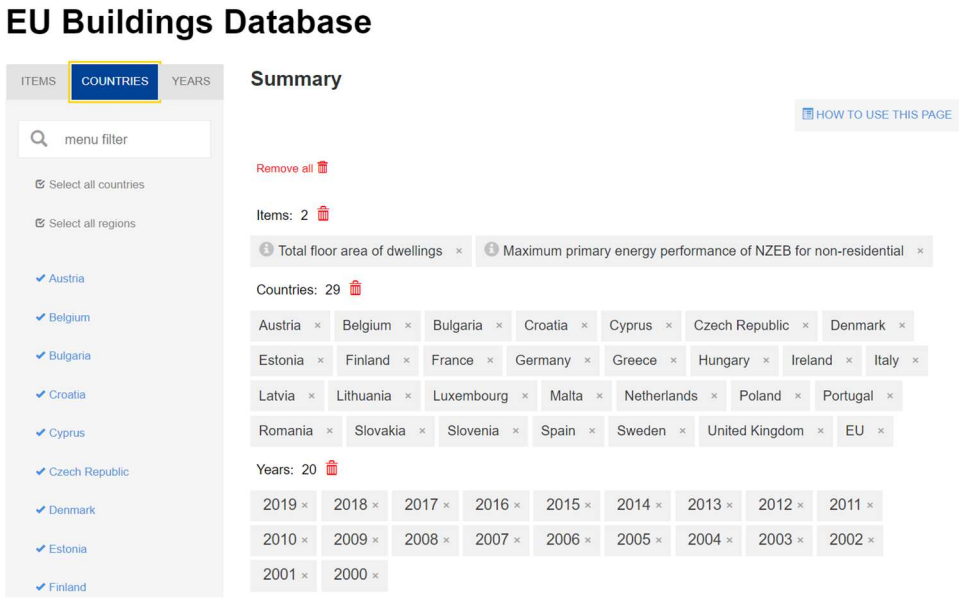


Figure 6: View of the EU Building Stock Observatory

	Summary of the core data provided by Eurostat:
Governance	Highest standards required by European Commission and expert compiled and reviewed in combination with Member States.
Data architecture	Strong and detailed data architecture designed to respond to specific policy demands by European Commission and Member States.
Integrity	High data integrity as provided by Member States.
Completeness	Complete with respect to the question being asked.
Timeliness	Available via an online portal and providing latest updates done frequently by Eurostat team.
Adaptability	Fully adaptable to the frame of the European Commission mandate.
Accuracy	Within its frame, highly accurate and well checked.
Comprehensiveness	Comprehensive within its defined frame.
Clarity	Very clear and articulated through multiple views, tools and with extensive online training resources.
Frequency	Typically, annual as tailored to the frame.
Distribution	Very widely distributed through European Commission and Member States' publications.
Review	Expert peer reviewed and guarantees from legal code and Member State agency.

3.2.2 IEA

In its annual World Energy Investment (WEI) report, the IEA uses a limited set of empirical data combined with estimates as part of a largely top-down methodology to assess **levels of investments in energy efficiency across the buildings, transport and industry sectors**.

In the buildings sector, a key source of data are reports on levels of grant or other national subsidy spending to promote energy efficiency in buildings.

Specific sources include:

- Government budgets
- Annual reports of energy efficiency programmes including loans, grants and energy efficiency obligations
- Academic studies
- Industry and market research studies
- Construction sector indices
- Studies of capital cost requirements

Information obtained from these sources is validated and supplemented through communication with private and public sector stakeholders. Historically, the IEA has tracked this information for 14 countries globally - United States, Canada, China, India, Korea, Japan, Australia, Germany, France, United Kingdom, Brazil, Norway, Switzerland and Turkey – whereby the information available as per the sources listed above varies across countries. Global totals are estimated or extrapolated using the information gathered from these countries (a similar approach may be pragmatic within the EU, using extrapolations to derive EU total investment in cases where robust data is missing for some MS).

To determine baselines and to frame the investment numbers, data from the IEA's Energy Technology Perspectives (ETP) model are used to indicate the size and age of the building stock and its projected energy use. This data is then supplemented by macro-economic indicators, e.g., population, GDP, inflation, etc., provided by the OECD and the World Bank.

Information on **buildings** codes (notably energy performance requirements) is also an important component in generating the final investment estimates. Specifically, based on available data from sources listed above, the IEA obtains or estimates the investments required to achieve the energy performance required to meet the legal code. Any investments above this level are considered incremental and comprise the actual energy efficiency investment as per the IEA's methodology. Information such as average investment per m^2 in new construction or retrofits to achieve an energy performance level as enshrined in

codes (and expressed in kWh/m^2, for example) is therefore the important data pillar within the IEA's approach to estimating building efficiency investments.

For the **industry** sector, an important data source is all published data on the uptake and, where applicable, incentives related to industrial energy management systems, such as ISO 50001. Industry associations or other sector specific representative bodies are an important source of such information.

In general, in industry, empirical and bottom-up data sources are more limited when compared with the buildings sector. As a result, the IEA relies on modelling to supplement this lack of information. As per the IEA's WEI 2020 Methodology Annex[31], incremental investments in industry energy efficiency is "calculated based on the average technology efficiency in a recent base year. The result is modelled on a regional basis and based on the realized level of energy savings in a sector and energy saving cost curves in the World Energy Model."

For **transport**, the IEA relies on a combination of purchased market studies, notably from sector data service IHS Markit, along with any public data and Marklines, a global automotive industry portal. The Global Fuel Economy Initiative (GFEI) provides an important source of additional data as well as methodological guidelines for determining incremental investments.

The IEA provides various data products, including a database on energy efficiency.[32] The IEA energy efficiency database allows to explore and compare, for example, the energy savings due to energy efficiency, and provides corresponding data tables (see Figure 7).

Figure 7: Screenshot of the IEA energy efficiency database Excel tool

The IEA is often cited as being the most reliable and credible source on energy efficiency investments globally. However, and in a reflection of the difficulty of this task, the agency's approach suffers from limitations that EC policy makers

31 https://iea.blob.core.windows.net/assets/56a29ba6-1c0a-41c4-8046-014a0bb77245/WEI2020MethodologyAnnex.pdf

32 https://iea.blob.core.windows.net/assets/983090db-ca9d-496e-b8bc-32a1a1d86852/IEAEEIdatabase_Demoandavailability_Rev.xlsb

should take into account as they develop future efforts in this area. Several of these limitations are already cited in the summary below, which is based on the data quality assessment used in this report. In simple terms, the IEA's challenges can be summarised as follows:

- A revision of the energy efficiency investment methodology has been **delayed** by the IEA several times in consecutive years, suggesting the topic may be overtaken in priority by other urgent matters;

- The source data for the IEA's methodology is not necessary published in a **transparent** manner, whereby researchers and experts may lament that details of the IEA's approach is contained in a 'black box', which creates difficulties in terms of analysis while complicating any incremental improvements to the methodology.

Recently, the IEA has upgraded their energy efficiency indicators database, which can be found here: https://www.iea.org/data-and-statistics/data-product/energy-efficiency-indicators?utm_source=SendGrid&utm_medium=Email&utm_campaign=IEA+newsletters.

The IEA is continuously working on increasing database's geographical coverage which currently covers end-use data and indicators across final consumption sectors 61 countries, territories and economies. Monitoring energy consumption is of course crucial for assessing the effectiveness of energy efficiency improvement measure on a sectoral level. Unfortunately, linking that information to investment information is far from trivial (c.f. section 4.1).

	**Summary of the data provided by the IEA:**
Governance	The IEA method is public and reviewed periodically. Member States have data provision agreements with the IEA that are governed by the IEA Governing Board and the IEA's modelling and expert teams review the data provided.
Data architecture	The IEA data architecture is negotiated with IEA member countries as a core, and then different departments of academics define the architecture which best serves their tasks and reports.
Integrity	The IEA data is sourced from member countries and acquired from industry or market sources. The combination, estimation and modelling algorithms are sense checked by external reviewers in many cases and discussed in working groups.
Completeness	In energy efficiency, the investment data is patchy and extrapolated using the methods described in the methodology. This differs between sectors.
Timeliness	IEA publications are annual and the data usually relates to the prior year.

Adaptability	The main purpose of IEA energy efficiency investment data is to track global relative flows year-on-year for reporting against member country targets and regional comparisons. The adaptability is constrained to this.
Accuracy	IEA data is considered in high regard, but all estimates and extrapolations and methods employed are not as accurate as bottom-up approaches.
Comprehensiveness	IEA covers the main areas required for energy efficiency investments.
Clarity	IEA reporting is clear and fit for its purpose at the global level.
Frequency	IEA publishes annually and data is received upon delivery.
Distribution	IEA reports are public or available at cost from the IEA online store.
Review	IEA work is extensively expert peer reviewed.

3.2.3 EN-TRACK

The EU-funded EN-TRACK[33] 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. Based on this data, future users[34] will be able to **benchmark and compare** the performance of energy efficiency measures (EEMs) within buildings or buildings portfolios against EEMs in buildings in a similar category/geographical area. In addition, or simultaneously, users will be able to compare the performance of their building or portfolio as a whole in terms of energy consumption, which can also and notably be expressed in cost and carbon terms.

During the 4th meeting of the Working Group, EN-TRACK project lead Stoyan Danov from the Spain based research institute CIMNE (Centro Internacional de Métodos Numéricos en la Ingeniería) presented an overview of the project and took part in an active WG discussion on the tool. The following information provides a snapshot of the project with a focus on some of the themes and topics that emerged in the WG meeting.

33 Energy Efficiency Performance-Tracking Platform for Benchmarking Savings and Investments in Buildings (EN-TRACK), EU Horizon 2020 Grant Agreement 885395

34 The project is due for completion in 2023, with platform development underway at the time of writing of this report.

Table 5: Potential EN-TRACK users and their drivers for decision-making[35]

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

EN-TRACK aims to be a 'one-stop-shop' for insights on the energy, financial and other performance of buildings, elaborating on existing efforts within DEEP (as discussed in 3.2.4), 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 and EnerInvest. Relevant databases and resources from outside of Europe, notably the Building Performance Database (BPD) developed by the Lawrence Berkeley National Laboratory (LBNL) at the University of California Davis, provide further inputs for EN-TRACK whereas relevant and feasible.

Value proposition development

An important part of the project, which runs throughout 2023, is to identify potential users of the platform and to understand their needs and drivers in order to develop platform services. As per Table 6 EN-TRACK has identified building owners and operators, lenders and investors and policy makers as core target users, whereby services could resonate across multiple user groups.

The development of EN-TRACK services is an iterative and ongoing process that aims to align with the users and their needs/drivers, as outlined in Table 5.

Table 6: Overview of EN-TRACK audiences, service categories and indicators

Audience	Service Categories	Indicators

35 Source: EN-TRACK Deliverable 1.1: EN-TRACK overall requirements and data model, https://en-track.eu/deliverables/

Building Owners and Operators	Benchmark and compare the performance of buildings before and after projects / EEMs	• Baseline energy consumption • Actual & forecast electricity and/or thermal energy consumption • Energy use intensity (EUI) expressed in kWh/m2 • Project capex and opex • Projected savings against baseline
Lenders and investors	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.	• Payback • Return on investment (ROI) • Internal rate of return (IRR) • Other standard financial indicators
Policy Makers	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 • €/tCO2e saved per € spent on grant funding • Average % difference in savings (€/tCO2e) between certified and non-certified projects

The service categories and corresponding indicators contained in Table 6 are indicative rather than comprehensive – other/additional indicators will continue to evolve and will be refined as the platform is finalised. In practice, the platform is designed to be flexible, whereby the EN-TRACK solution combines automatically collected data (e.g. energy consumption time series, weather) with user provided data (e.g. floor area, location, usage) necessary to provide context for the analyses. If this information can be obtained from other sources, e.g. energy performance certificates, the platform is able to absorb these, whereby such data is checked for consistency before use. In this sense, EN-TRACK is similar to the US Environmental Protection Agency (EPA) Energy Star tool.[36]

Platform user interface

The EN-TRACK platform, including its final web presence and user-interface, is still under development. However, initial mock-ups exist and are currently being iterated within the project based on a variety of inputs. As per Figure 8 and Figure 9, the aim of EN-TRACK from a user perspective is to be intuitive and to allow for

36 https://www.energystar.gov/buildings/tools-and-resources

easy access to benchmarking and performance data. Please note the mock-ups shown in these figures are subject to change.

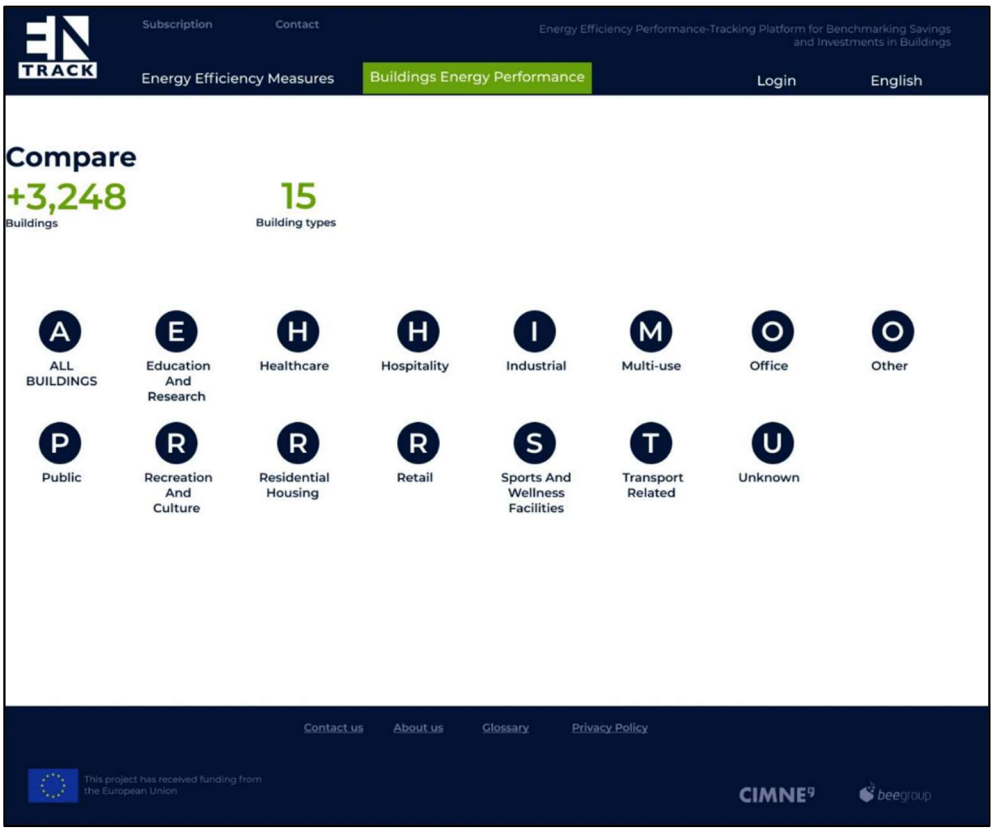


Figure 8: EN-TRACK user interface mock-up 1

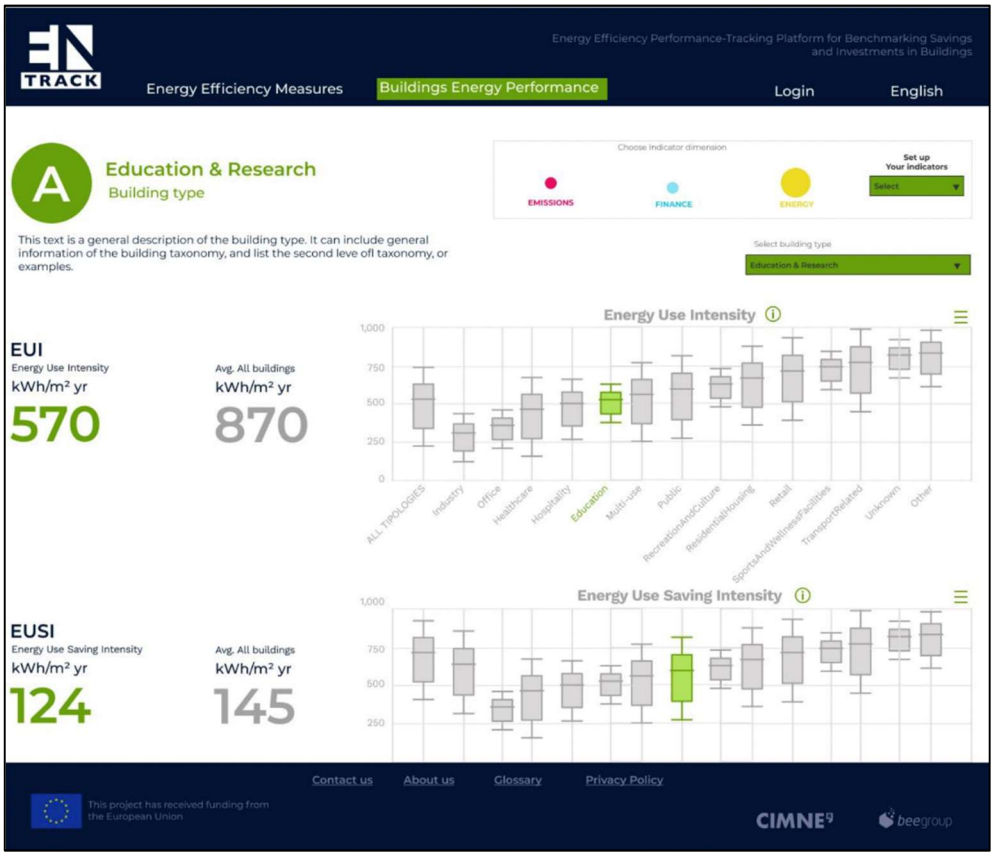


Figure 9: EN-TRACK user interface mock-up 2

Challenges

The most important or core challenge for EN-TRACK relates to large scale data collection across multiple buildings, contexts, and geographical area. In addition to any technical challenges related to this type of data collection, EN-TRACK developers need to contend with specific challenges related to obtaining data from – and presenting the value of EN-TRACK to – a range of stakeholders, data owners and platform end-users.

To a large degree, the EN-TRACK project faces challenges similar to those faced by the IEA, the EC, this EEFIG WG and many other organisations when it comes to large scale data collection. Indeed, challenges faced during the development of DEEP resonate strongly within EN-TRACK.

Addressing these challenges is a core part of the go-forward approach for EN-TRACK, whereby the value proposition development and 'voice of the customer' activities as reflected in Table 5 and Table 6 remain central to the development of targeted solutions. In addition to active efforts by the project, such as the organisation of focus groups, market research and value proposition development, EN-TRACK can potentially benefit from technologies and tools such as data hubs for smart meter data and billing information provided by utilities (under agreed data handling).

	**Summary of data assessment for EN-TRACK based on current status:**
Governance	All data is managed internally within the project according to best practice data handling rules and norms.
Data architecture	EN-TRACK is built on a detailed data model as is commonly used in the development of software tools, whereby the model is designed to be flexible in order to accommodate disperse datasets from multiple sources.
Integrity	EN-TRACK aims to develop its analytics and outputs based on empirical data on energy and financial performance of energy measures. In this respect, the integrity of the data in the platform is high since it relies as little as possible on modelled or estimated data.
Completeness	The completeness of the dataset will vary or depend on the setting and expectation – a fully comprehensive set of data across thousands of buildings and multiple geographical areas will take time and resource to develop. Platform owners are encouraged to establish numerical interim milestones for completeness in order to track progress on completeness.
Timeliness	Providing real-time energy use data is not necessarily a requirement of EN-TRACK, however the platform does need to ensure that data used for comparison is recent, particularly if energy prices are fluctuating strongly.
Adaptability	The data model of EN-TRACK is designed to permit a significant amount of adaptation according to user needs and variability related to data inputs.
Accuracy	Data accuracy is expected to be high in EN-TRACK (link to integrity).
Comprehensiveness	To provide a value added to the users, the data in EN-TRACK will need to be comprehensive across multiple indicator categories (energy performance as well as financial performance). Ensuring comprehensiveness across multiple indicators will therefore be critical to EN-TRACK, whereby challenges related to consistency are likely across multiple buildings and measures.
Clarity	Data inputs for EN-TRACK are neatly defined according to standard indicators that the platform software can 'understand'. Developers will use standard templates and input forms to support this.
Frequency	The frequency of collection will vary according to projects and buildings – some data providers may upload a bulk set of historical data, while others may provide monthly or other frequency 'feeds' of data to the platform.
Distribution	As part of post-project commercialization efforts, EN-TRACK will likely offer a limited public set of data as well as more extensive datasets (or rather benchmarking analysis) in exchange for payment.
Review	The data in the platform is reviewed by developers as part of standard due diligence and quality assurance. In addition, platform users will effectively provide peer review as part of regular usage, for example through comment or other functions that allow users to flag errors, questions, etc.

3.2.4 European Investment Bank Investment Survey: EIBIS

Surveys are a powerful tool to collect and monitor data on energy efficiency investments by selecting a random but representative sample of companies, which can then be used to project to appropriate national and EU-wide investment levels.

The **European Investment Bank Investment Survey** (EIBIS) is a survey that has been developed by the European Investment Bank (EIB) to assess and monitor a variety of issues relevant for European business, including investments in energy efficiency. It was established to track non-financial corporate investment activities in the 27 EU Member States, the UK and, since 2019, the US as a benchmark. It is issued on an annual basis **since 2016** and covers **manufacturing, services, construction and the infrastructure sector in four company size classes** (micro, small, medium and large).

The EIBIS 2021 was 'in the field' between May – August 2021, including specific questions on digital, climate, energy efficiency and COVID-19 impact. The general module of EIBIS captures, on a yearly basis:

- investment activities (expenditure by area; by purpose; etc.) and plans (investment pipeline; investment gap; etc.)
- barriers to investment (access to finance, regulation etc.)
- sources of investment finance (including name of last bank)
- firm characteristics (number of employees; age; etc.) and performance measures (growth; TFP[37]; etc.)

The survey responses can be matched to firm balance sheet information (assets; liabilities) and firm income statements (profit & loss; interest payments; etc.) as reported in the Bureau van Dijk ORBIS database[38] as well as bank balance sheet information of banks providing identified loans coming from the Bureau van Dijk Bank Focus database, which also includes historical data.

The results of the EIBIS are based on around 12,000 completed interviews across all 27 EU Member States, over 800 in the US, covering non-financial corporates split by SMEs (5-250 employees) and large firms (250+ employees). The representativeness of the sample is assured at highest scientific standards across:

- Countries (27 EU Member States, UK and US)

37 Total factor productivity (TFP) is the portion of output not explained by the amount of inputs used in production. It reflects the overall efficiency with which labour and capital inputs are used together in the production process.

38 https://login.bvdinfo.com/R0/Orbis

- Four firm size classes (micro, small, medium, large)
- Four sector groupings (manufacturing, services, construction, infrastructure)

The sampling frame is based on the BvD ORBIS database using unconsolidated accounts (the non-financial corporate sector in EU27, UK and US, with at least 5 employees falling into economic activities in NACE codes C to J). The weighting when projecting the sample results to the full population of companies is based on Eurostat Structural Business Statistics (SBS) population data for the EU, and US Census Bureau data as well as US Bureau of Economic Analysis (BEA) data for the US. The ORBIS sampling frame coverage versus Eurostat SBS is good (in line with Kalemli-Ozcan et al. (2015) and Bajgar et al. (2020)).

The country distribution of the samples in wave 2021 is shown below:

Country	n. obs	Country	n. obs
Austria	482	Italy	602
Belgium	480	Latvia	366
Bulgaria	480	Lithuania	400
Croatia	481	Luxembourg	180
Cyprus	182	Malta	180
Czech Republic	480	Netherlands	482
Denmark	480	Poland	480
Estonia	401	Portugal	481
Finland	480	Romania	480
France	600	Slovakia	400
Germany	602	Slovenia	401
Greece	402	Spain	600
Hungary	481	Sweden	482
Ireland	355		

Table 7: Country distribution of the samples in wave 2021

An example of the coverage ratios of EIBIS sampling frame against EU SBS is shown below:

ITALY	5-9	10-49	50-249	250+
Manufacturing	0.94	0.96	0.99	1.06
Services	1.02	1.03	1.04	1.01
Construction	0.92	1.08	1.04	1.43
Infrastructure	0.80	1.06	1.00	1.03

Table 8: Coverage ratios of EIBIS sampling frame against EU SBS, Italy

The coverage ratios for number of firms of EIBIS sampling frame compared to Eurostat SBS in 2019 is depicted here. For all countries imputed cases were kept only if these were based on financial information that is no older than 3 years. The calculations were carried out by IPSOS and this table is a replication of Table 5 of IPSOS (2019). The methodological details can be found in the EIBIS

methodology report (https://www.eib.org/attachments/eibis-methodology-report-en.pdf).

The first and main question on energy efficiency in the EIBIS asks the following:

Q49c. **What proportion of the total investment in the last financial year (2020) was primarily for measures to improve energy efficiency in your organization?**

The answers to that question are shown in Figure 10, representing energy efficiency investment in the EU (% of firms), wherein the whiskers represent 2X standard error of mean estimation.

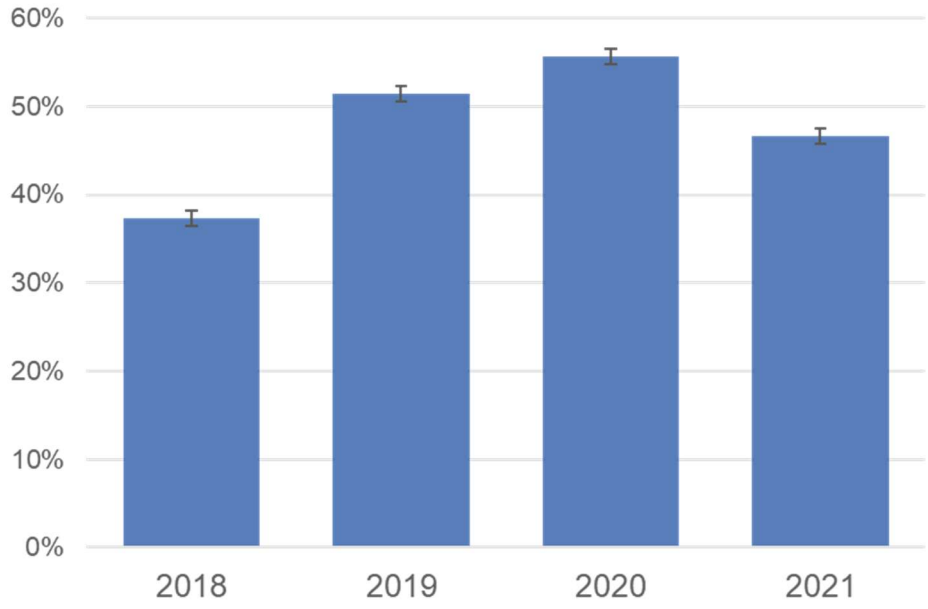


Figure 10: Energy efficiency investment in EU (% of firms). Source: EIBIS

This result can be further segmented by firm size and sector:

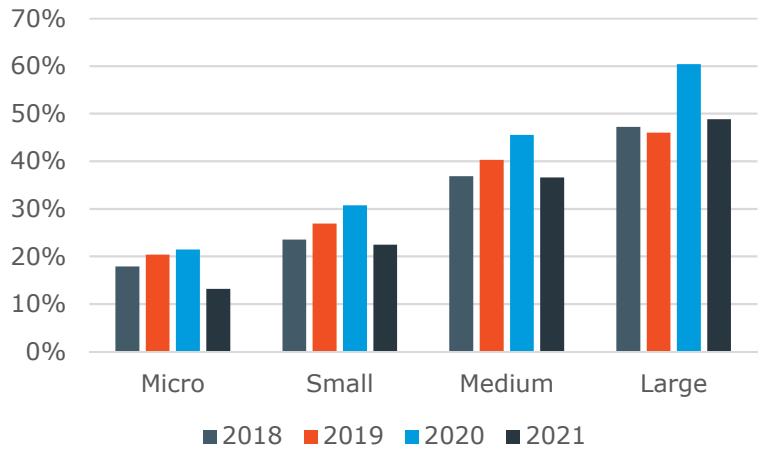


Figure 11: Energy efficiency investment in EU (% of firms), segmented by firm size

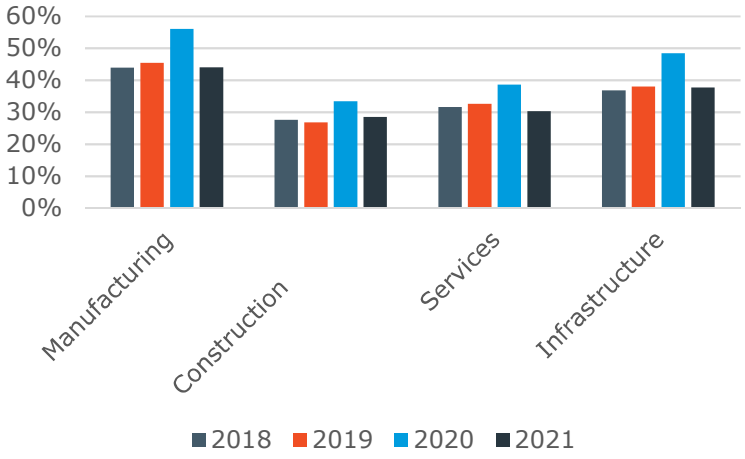


Figure 12: Energy efficiency investment in EU (% of firms), segmented by sector

The number of firms investing in energy efficiency across EU countries can be analysed as well (% of firms):

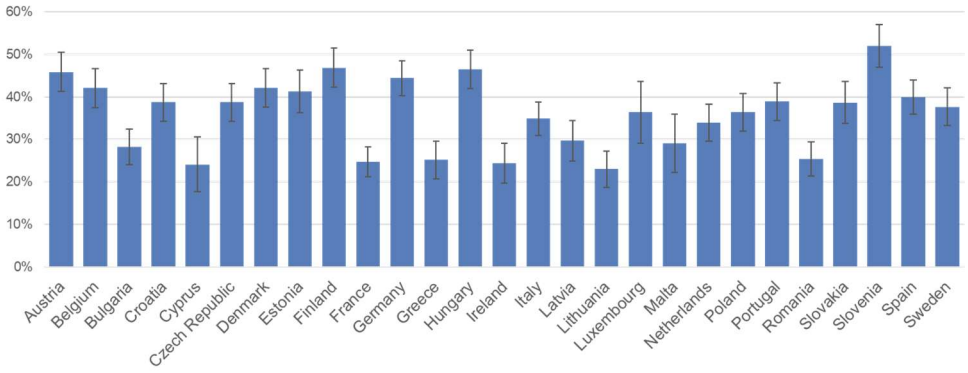


Figure 13: Percentage of firms investing in energy efficiency across EU countries

Energy efficiency investment in EU countries as percentage of investments is shown below.

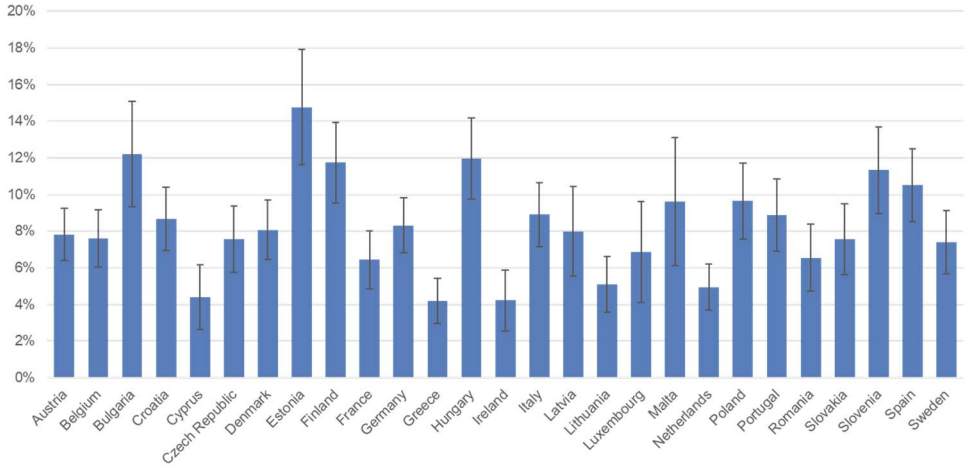


Figure 14: Energy efficiency investment in EU countries as % of investments

The most recent wave of the EIBIS is in the field between April – July 2022, focussing on the impact of COVID-19 on firm performance (e.g. turnover), firm debt position, financial support and investment plans, both short-term and long-term impact of COVID-19 on innovation, digitalization, etc. Additionally, climate change and adoption of digital technologies are specifically addressed in the survey. Overall, the EIBIS is a powerful and established tool to use sampled data to estimate energy efficiency investments of companies in the European Union. Being run by a major European institution, the EIB, the EIBIS is a tool directly accessible to European authorities. Its unified methodology across Member States means that its results can be considered to provide a sound and consistent picture across all Member States.

The EIBIS dataset provides the following information:

Indicators	• Average share of investment in different asset types, • Expected investment in the current financial year compared to the previous, • Expected investment in the current financial year compared to the previous: net effect, • Firm investment in the last financial year compared to the previous year, • Firm investment in the last financial year compared to the previous year: net effect, • Investment intensity (total investment/number of employees), • Purpose of investment in last financial year, • Composition of external investment finance, by source, • Composition of investment finance, by source, • Proportion of a firm's commercial building stock that satisfies high or highest energy efficiency standards, • Proportion of a firm's machinery and equipment, including ICT, that is state-of-the-art, • Proportion of investment directed towards measures to improve energy efficiency.
Countries	All EU countries
Years	All years
Subgroups	All subgroups

Table 9: EIBIS dataset overview of available information

An example of the data analysis tool (https://data.eib.org/eibis/download):

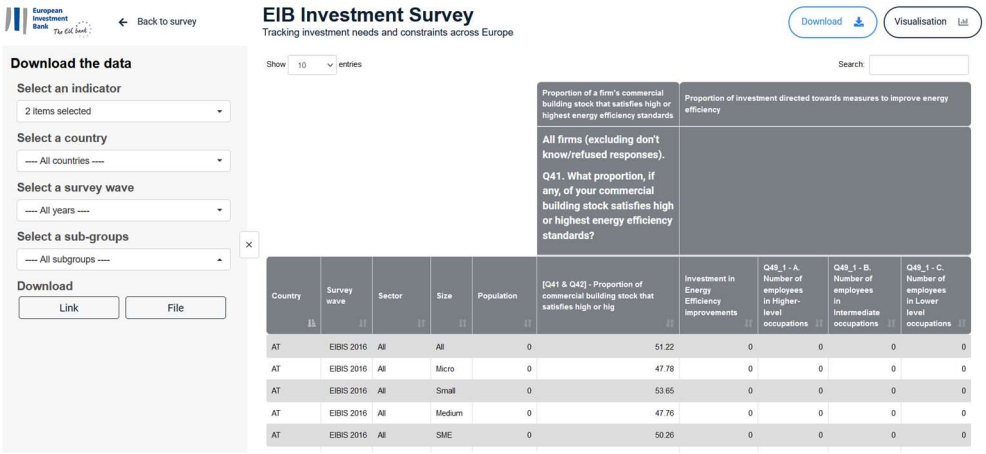


Figure 15: Screenshot of the data analysis tool

An example of the downloadable data is shown here for the EIBIS questions.

- Q41. What proportion, if any, of your commercial building stock satisfies high or highest energy efficiency standards?
- Q49. Proportion of investment directed towards measures to improve energy efficiency

Country	Survey wave	Sector	Size	Q41	Q49
AT	2016	All	All	51.22	0
AT	2016	All	Micro	47.78	0
AT	2016	All	Small	53.65	0
AT	2016	All	Medium	47.76	0
AT	2016	All	SME	50.26	0
AT	2016	All	Large	52.26	0
AT	2016	Manufacturing	All	51.77	0
AT	2016	Construction	All	49.81	0
AT	2016	Services	All	49.2	0
AT	2016	Infrastructure	All	53.54	0
...					

Figure 16: Downloadable data excerpt for Austria. Source: EIBIS

	Summary of the core data provided by the EIBIS:
Governance	Sound governance structure as outlined in the EIBIS documentation for conducting the survey.
Data architecture	Data structure are accessible via the online analysis tool.

Integrity	Quality assurance process within the EIB ensures methodological integrity.
Completeness	All EU Member States, sectors NACE group C (manufacturing), F (construction), G (wholesale and retail trade), I (accommodation and food services activities); D and E (utilities), H (transportation and storage), J (information and communication). SME and large firms.
Timeliness	Intermediate, given a yearly frequency.
Adaptability	Questions are adapted for each wave.
Accuracy	Projections based on sound sampling scheme.
Comprehensiveness	The sample of 15.000 European companies across all sectors ensures good comprehensiveness, investments in energy efficiency are addressed by explicit questions in the survey.
Clarity	No complex methodology involved, method can be understood based on the documentation.
Frequency	Yearly update frequency.
Distribution	EIBIS report and data is accessible via online tool.
Review	Results are reviewed by EIBIS team.

3.2.5 De-risking Energy Efficiency Platform: DEEP

Granular data is a prerequisite for tracking investments into energy efficiency. DEEP (DEEP - De-risk Energy Efficiency Platform eefig.eu) is an **open-source database for energy efficiency investments performance monitoring and benchmarking** launched and maintained by EEFIG. It provides an improved understanding of the real risks and benefits of energy efficiency investments by providing market evidence and investment track records. Currently, it provides data on 24,000 real energy efficiency projects in buildings and industry from 32 data providers across EU27 countries and the USA, UK, Turkey, Serbia, Bosnia and Herzegovina, Georgia, Armenia.

DEEP 2.0 was launched in June 2021 and provides a number of improvements, including a new website structure where more information is directly available on the landing page and is accessible without registering as a user or logging in. Furthermore, new data fields for buildings have been added, including fields aligned with the EU taxonomy. The improved benchmarking tool allows users to benchmark their own portfolio against DEEP data as well as benchmarking between user defined subsets of the DEEP data. It also provides advanced risk indicators including skew[39], kurtosis[40] and Value at Risk[41]. DEEP data and analysis can also be accessed directly through the software intermediary API.

39 Skewness is the degree of asymmetry observed in a probability distribution.

40 Kurtosis is a statistical measure that defines how heavily the tails of a distribution differ from the tails of a normal distribution.

41 Value at Risk (VAR) is used to predict greatest possible losses over a specific period.

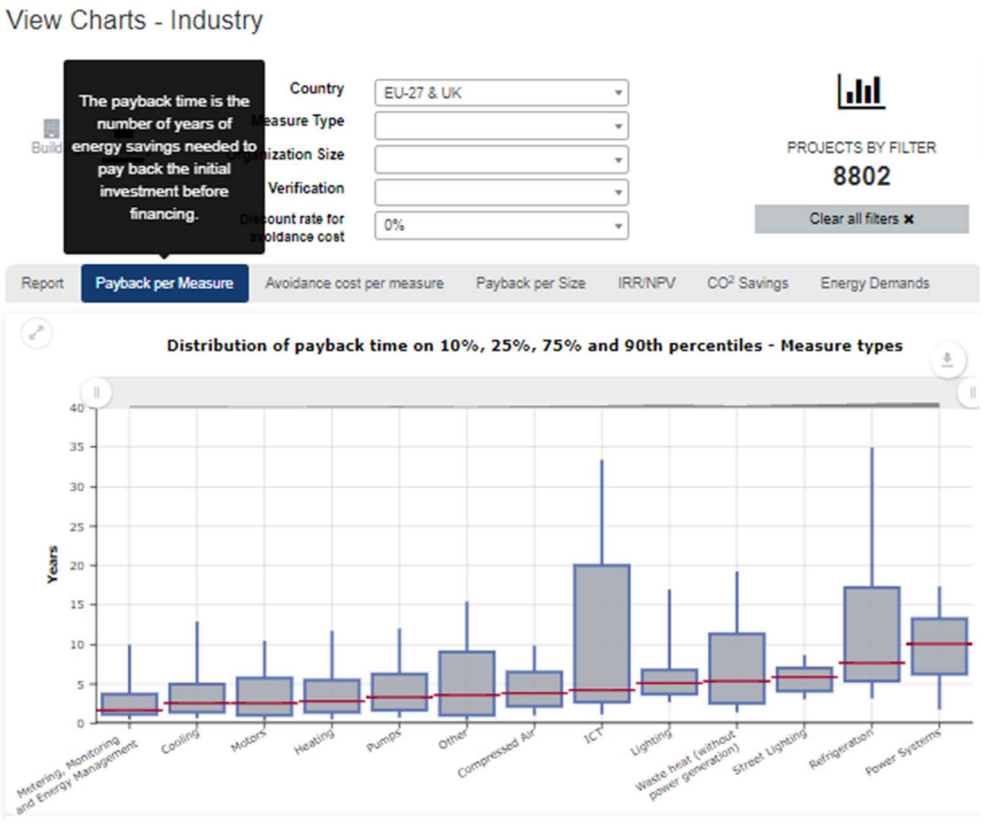


Figure 17: Example of analysis provided by DEEP.

Availability of granular, project-level data is key for the mission of the DEEP Working Group. The DEEP database is a **best-in-class example of a project-level database**, which provides a blueprint for sectoral data structures to collect and monitor data on energy efficiency investment. The EEFIG database can be found on the EEFIG website and its WG has produced extensive documentation on its structures and approaches, which we shall not duplicate here**.**

	Summary of the data provided by the DEEP:
Governance	Database run and operated by the DEEP project, financed by DG Energy and maintained by an expert consortium.
Data architecture	Sectoral data structures were based upon a comparison of best in class US DOE and EU approaches and is accessible via an online (analysis) tool.
Integrity	Key components are quality assured by an independent consortium before being uploaded. More complex information can only be provided via dropdown selections.
Completeness	DEEP is a sample provided by its 34 participants and it covers over 24,000 projects in Europe and the USA. It is an open source database but each project may not have complete data complete and it thus provides an incomplete data view.
Timeliness	High, quarterly updates are produced. Existing data can be assessed in real-time.

Adaptability	Intermediate, fields and information may be updated, however, this only provides information for future cycles.
Accuracy	Accuracy/Integrity provided through predefined table and data structure and validated by the input consortium.
Comprehensiveness	DEEP delivers for voluntary use of finance providers and is designed as a benchmark tool to provide deal-level confidence.
Clarity	No complex methodology involved, the public collection method can be understood based on the instructions.
Frequency	New projects can be uploaded at any time. Quarterly updates and uploads are programmed within the database.
Distribution	DEEP is a public resource that is always online. It has no other proactive distribution other than through EEFIG/EC channels.
Review	Quarterly expert review of new projects before upload.

3.2.6 OPERAT

The French Construction and Housing Code, Legislative Part, Book I, Title VII, Chapter IV defines the French objectives to reduce energy consumption and defines reporting requirements to monitor the fulfilment of these objectives. The overall objective is set by a reduction in final energy consumption for all buildings in scope of at least 40% in 2030, 50% in 2040 and 60% in 2050 as compared to 2010[42].

The law also defines the group of taxable persons that need to report on their status in energy consumption on an annual basis. These are all owners, and where applicable lessees, of buildings (partially) used in the tertiary sector if their floor area exceeds 1000m².[43]

The reporting was initially supposed to start in September 2021 but has been postponed by one year, i.e. to start from September 2022. From that date on, an annual reporting on current energy consumption is mandatory and may lead to fines, if not reported in time.

Database for collection

In order to structure the data collection as set out above, a database has been created and will be run by ADEME[44], a public operator, placed under the supervision of the French Ministry of Ecological and Solidarity Transition. The database is called **OPERAT ("Observatoire de la Performance Énergétique de la Rénovation et des Actions du Tertiaire")**.

42 https://www.legifrance.gouv.fr/codes/article_lc/LEGIARTI000043819501/2021-07-31

43 https://www.legifrance.gouv.fr/codes/article_lc/LEGIARTI000043819501/2021-07-31

44 https://www.ademe.fr/

Figure 18: Information stored in OPERAT.

The OPERAT database is organised into three types of information tables, the first storing the user account data, the second listing the relevant objects (called entities) and the third storing the consumption of energy. The key types of information stored, are summarized in Figure 18. The information on energy consumption (by consumption type) is further broken down into detailed information of the source of energy, particularly electric power (kWh), natural gas (kWh), liquid natural gas (kg), propane gas (per m³ and kg), butane gas (per m³ and kg), fuel (litre), coal pellets/briquettes (kg), coal (kg), industrial wood (kg), forest firewood (kg), wooden briquettes (kg), wooden logs (kg), network heat (kWh) and network cooling (kWh). As such, the information on the consumption of energy is very detailed. As opposed to energy consumption that is based on combustible material, network supply and electric power, the OPERAT database does not contain information on energy consumed from wind, solar energy, water or geothermal sources.

Contrary to DEEP (cf. Section 3.2.5) which is focusing on recording energy efficiency measures and projects and their costs and payoffs, **OPERAT aims at providing a broad dataset on the status quo and history of energy consumption – not investment - to review the overall levels of energy consumption** in France (both on aggregated and individual level). Energy consumption could provide an additional and more timely view into energy efficiency improvements – if they can be distinguished from changes in energy demand.

	Summary of the data provided by the OPERAT:
Governance	Database run and operated by ADEME.
Data architecture	Data structures are accessible via an online (analysis) tool.
Integrity	Automatic data quality checks are envisaged.
Completeness	French buildings information only.
Timeliness	Unclear, assuming on-demand based upon most recent available year.
Adaptability	Fields and information may be updated, however, this only provides information for future cycles.
Accuracy	Predefined table and data structures provide a robust frame, and the reporting accuracy defines overall data quality.

Comprehensiveness	Full coverage of French real estate in the tertiary sector.
Clarity	No complex methodology involved, and methods can be understood based on the instructions.
Frequency	Yearly update frequency.
Distribution	Results are supposed to be accessible via automatic interface
Review	No specific review cycles known – assumed ADEME internal consistency checks.

3.2.7 Odyssee-Mure

The objectives of the Odyssee-Mure database (www.odyssee-mure.eu)[45] are to **evaluate and compare energy efficiency progress by sector**, in relation to the observed trend in energy consumption and to the EU targets. The **ODYSSEE** database contains 200 **indicators of energy efficiency**. The data can be used to evaluate energy efficiency policy measures and identify the "best measures" (2500). The **MURE** database, which provides **policy measures**, is implemented and stores data by sector.

In terms of procedures, 31 EU countries are represented by energy efficiency agencies, who provides inputs to this decentralised data collection. The legitimacy of the results stems from an in-depth exchange on methodologies, interpretation through workshops gathering ca. 60 experts. The harmonized data collection allows for data going «beyond the energy balance». A rapid updating (in less than one year) is performed including a quality check. The data dissemination process provides free access to non-profit organisations, sectoral and country profiles, national reports.

Specific communication tools provide analysis facilities for end users. Contributors to Odyssee-Mure include DG ENER, the Joint Research Centre (JRC), the European Environment Agency (EEA), Eurostat, the European Council for an Energy Efficient Economy (ECEEE), European Energy Network (EnR) , the International Energy Agency (IEA's EEUMD[46] for G20), in Latin America the UN-CEPAL (project BIEE & ROSE 25 countries)[47], in Mexico AFD-CONUEE[48], in Africa the MEDENER[49] including 7 Mediterranean countries, UN-Tunisia, in India the BEE[50], as well as on national level e.g. the German Ministry of Economic Affairs (BMWi).

The following energy efficiency indicators are available in Odyssee:

45 https://www.odyssee-mure.eu/ for EE indicators in Europe for EE https://biee-cepal.enerdata.net/en/measures for P&Ms in LACs; https://biee-cepal.enerdata.net for Indicators in LACs; https://www.biee-conuee.net/ for EE indicators in Mexico for indicators https://meetmed.org/wp-content/uploads/2020/04/A12_MEDOBSERVEER_Fr_Final.pdf in Mediterranean countries

46 Energy end use Data and Metrics

47 United Nations Economic Commission for Latin America and the Caribbean's Base de Indicadores de Eficiencia Energética (BIEE) and Regional Observatory on Sustainable Energy (ROSE)

48 French Development Agency and Comisión Nacional para el Uso Eficiente de la Energía collaboration

49 Mediterranean Association of National Agencies for Energy Management

50 Bureau of Energy Efficiency

Type	Level
1. Energy intensities	by sector & sub sector
2. Adjusted intensities	final and industry
3. Specific energy consumption	by sub sector & end-use
4. Benchmarked-specific sectors	steel, cement, paper, heating
5. Energy efficiency indices (ODEX)	final and by sector
6. Energy savings	final, by sector and sub sectors
7. Indicators of diffusion	by sector
8. CO_2 intensities	by sector & sub sector
9. Specific CO2 emissions	by sub sector & end-use
10. Fuel poverty	households
11. Sufficiency	by sub sector & end-use
12. Short term indicators	by sub sector & end-use

Table 10: Odyssee energy efficiency indicators

Overall, the Odyssee database can used for the following kinds of analyses and calculations:

a) Energy efficiency index to assess energy efficiency improvements at sector level.

b) Energy savings to quantify the amount of energy saved over a period or for a given year.

c) Financial indicators to show the financial benefit of energy savings for households.

d) Benchmarking indicators to assess how each country performs compared to other countries.

e) Decomposition of energy consumption variation to show how energy efficiency improvements have impacted the energy consumption of the country.

f) Avoided CO_2 emissions to show what is the effect of energy efficiency improvement on CO_2 emissions.

Based on the data available in the Odyssee database, the Odyssee-Mure project has found the following **high-level energy efficiency results**:

- Specific consumption per m^2 for residential heating has decreased rapidly in most countries since 2000 (-1.7%/year on average in the EU).

- This trend has slowed significantly since 2014 in the EU (-0.6%/year vs. -2.1%/year before), and in several large countries (e.g. Netherlands, Austria), and to a lesser extent in France, with even an opposite trend in Germany.

- This inflection point recorded in Germany when comparing 2000-2014 and 2014-2019 is undoubtedly due to several factors: less new construction (-30% since the financial crisis), quality of renovation and construction (0.9% of the stock each year) and slowing down the spread of efficient heating systems (condensing boilers).

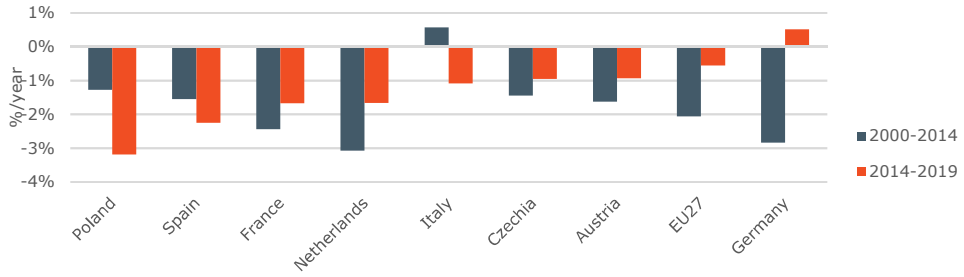


Figure 19: Specific consumption per m², expressed in % change per year

- Overall, the efficiency of final consumers increased by around 0.5% in 2020 (compared to 0.7%/year over 2014-2019), of which 0.4% for industry and 0.6% for households and transport:

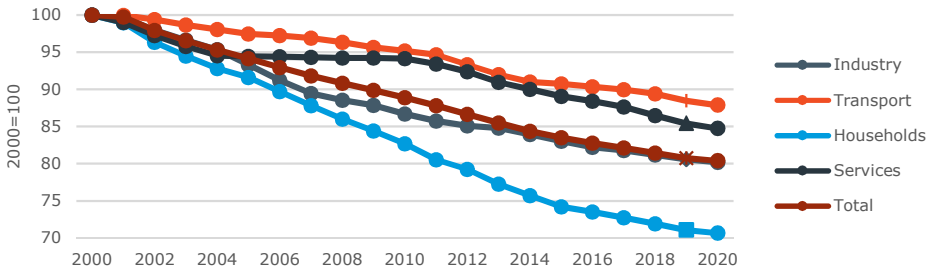


Figure 20: Overall energy efficiency of final energy consumers per sector

- The specific consumption of new diesel and gasoline cars has decreased again in 2020 in most countries, and quite significantly in some of them.

- This marked a net reversal of the trend 2014-2019, when this specific consumption increased in most countries and at EU level, due to two main factors: a decrease in diesel shares (from 56% in 2012 to 34% in 2019 at EU level) and a growing share of SUVs (from 25 to ~40%).

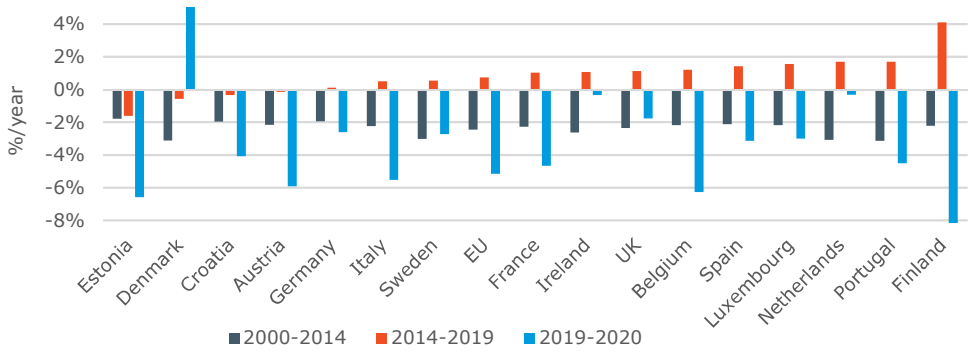


Figure 21: Test-cycle values for diesel and gasoline cars (l/100 km)

The MURE database, collects information on energy-related policy measures. MURE applies a harmonised approach to measure collection where measures are collected by National Teams using a measure collection template, which comprises a structured information on the measures and a detailed description. Additionally, there are guidelines on which measures to include/not to include (e.g. regional/local level) and how.

A user of the MURE database can search with descriptors as well as free text. The information is updated about once per year linked to National Energy Efficiency Action Plan/National Energy and Climate Plan (NEEAP/NECP) periods as far as possible. Based on the data input, quality controls are performed by the Technical Coordination (Fraunhofer ISI responsible for MURE), partly using automated controls.

In the MURE database there are quantified as well as semi-quantified impacts. Currently, around 30% of ongoing measures have quantified impacts (frequently the important ones). The database is used in the policy context, in particular in the NECP context.

In summary, the MURE database can be used to address the following questions:

- How many policies are implemented in the service sector?
- What are the new measures implemented in the EU?
- What are national measures which go beyond EU directives requirement?
- What are the regulations in industry, or the taxation in passenger transport?
- What is the policy mix for households, for space heating and for cars by EU countries?
- What are the policies designed to tackle fuel poverty?

- Which policies fulfil the Energy Efficiency First principle?
- What are the examples of sufficiency policies?
- What are the high impact measures in EU?
- What are the successful measures?
- How many countries have white certificates (energy obligation schemes)?
- Which methodologies are used to evaluate policies?
- Which country has the best overall energy efficiency score?

The database is accessible to registered users via a dedicated webpage (further information can be seen in a brochure[51]):

Figure 22: Screenshot of dedicated Odyssee database

	Summary of the core data provided by the Odyssee-Mure:
Governance	Provided by the Odyssee-Mure project team and ADEME.
Data architecture	Comprehensive and established data structures.

51 https://d1owejb4br3l12.cloudfront.net/brochure/global-energy-information-services-brochure-enerdata.pdf

Integrity	Common methodology and quality controls by the Odyssee-Mure project.
Completeness	High degree of completeness across EU Member States.
Timeliness	Accessed online through a registered user based on last input data.
Adaptability	Methodology and data collection can be adapted by the project, when required.
Accuracy	Granular data collection reduces the amount of assumptions, improving accuracy.
Comprehensiveness	Strong focus on energy consumption and efficiency, less so on amount of investments.
Clarity	Clear analyses can be derived from the data (see figures above).
Frequency	Approximately once per year.
Distribution	The access to the database is free for all EU Ministries, Concerted Action EED, EED Committee Members and EU universities and research centres for non-commercial uses and via subscription for other users.
Review	Performed by ~60 experts.

3.2.8 Climate finance landscapes

Climate finance landscapes have been produced by various institutions on global and national level. In this section, different climate finance landscapes are outlined bearing in mind that the methodologies applied by different organizations can be significantly different and adapted to specific data situation in the various countries examined. For detailed information about the data sets used and the respective methodology, please also refer to the mentioned organisations directly. In this section, we just try to assess the applicability of those methodologies to the rather specific scope of this Working Group, i.e. to recommend methods for monitoring investments in energy efficiency improving measures for buildings and companies only. No WG assessment for energy efficiency can be extrapolated into a general opinion on that work, but only reflect the narrow angle we need to take here for the purpose of this working group.

For example, CPI Global is regularly publishing global climate finance landscapes, which include investment sources, intermediaries, instruments and uses across various sectors (cf. Figure 23). Tracked mitigation investment in Buildings & Infrastructure totalled USD 27.7 billion on average in 2019/2020. However, limited data availability, especially in the private sector, means the amount tracked represents just a partial view.

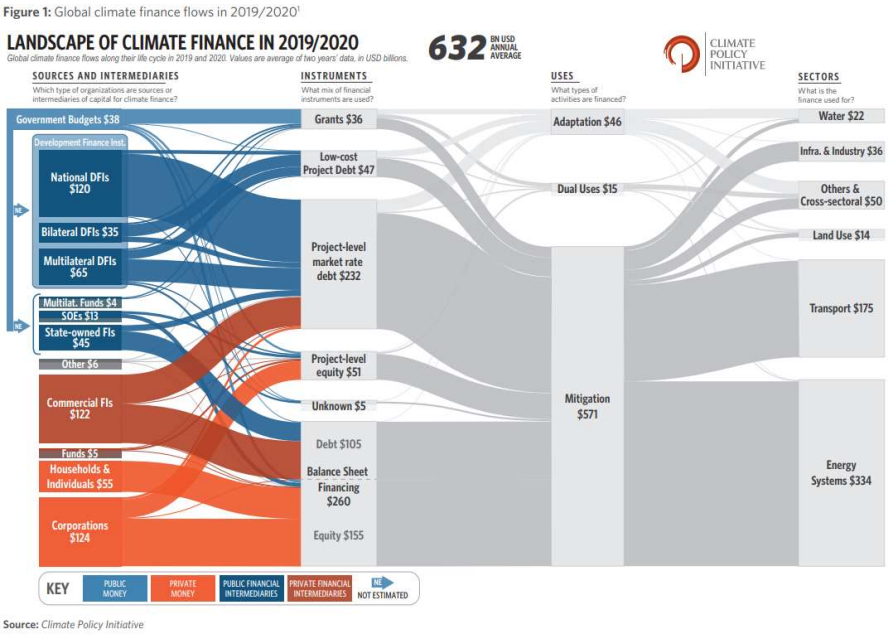


Figure 23: Global landscape of climate finance in 2019/2020 (produced by CPI Global)

According to the presentation of CPI Global in the Working Group, energy efficiency investments for buildings are difficult to track, as there is no consensus definition of what it is. Buildings are complex assets and buildings investments are fragmented and incremental, which leads to the observation that there is no adequate standard yet.

Previously, CPI[52] had adopted the global approach into a framework suitable for analysing the national level and applied it to the case study of Germany for the residential sector in the year 2010. To construct the map, a bottom-up approach was used for tracking investment at a technology/measure level, aggregating it on sector level and then to a country level. The map allows understanding who invests how much into what kind of measures and which intermediaries and financial instruments facilitate these flows. However, as can been seen in later landscapes produced by IKEM and reproduced in Figure 24, Figure 25, and Figure 26, the landscapes need to be adapted to national specifics regarding the segmentation of finance flows.

[52] See https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2013/5b-cutting-the-energy-use-of-buildings-policy-and-programmes/the-landscape-of-climate-finance-in-germany-a-case-study-on-the-residential-sector/2013/5B-393-13_Novikova.pdf/

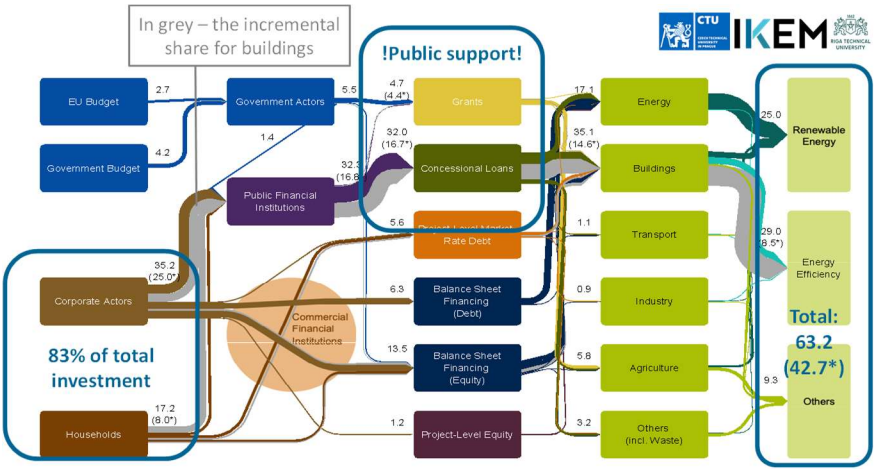


Figure 24: German climate finance landscape of 2016

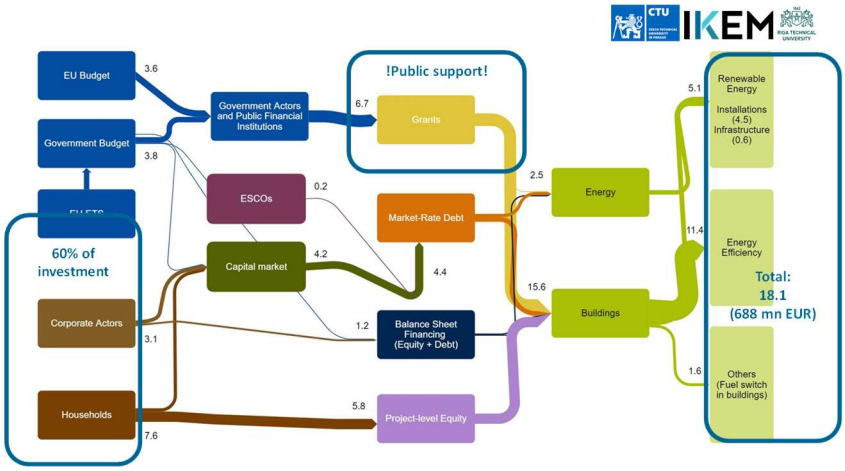


Figure 25: Czech climate finance landscape of 2017

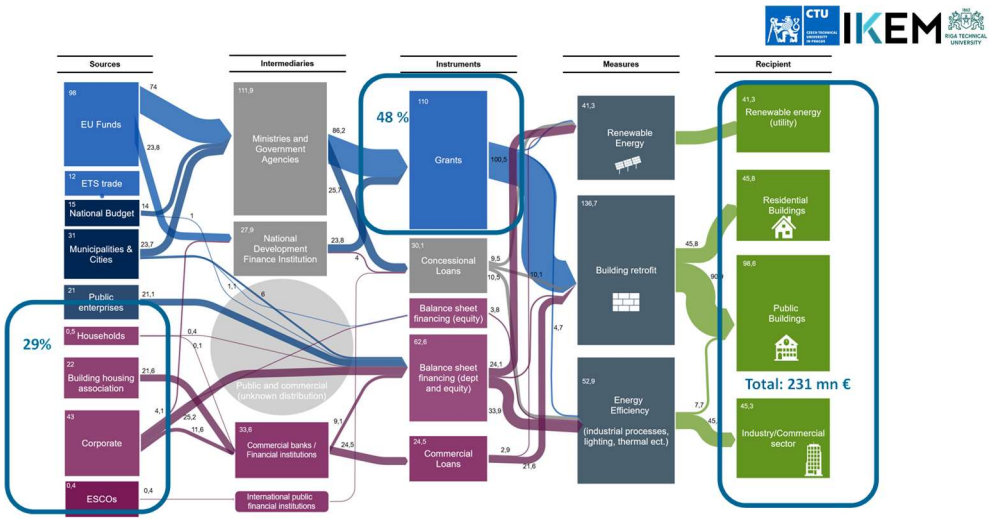


Figure 26: Latvian climate finance landscape of 2018

France is a role model in terms of climate finance data availability, as the disclosure of financial flows, which contribute to the national climate targets, is a legal obligation in France (Law no. 2015-992 for the Energy Transition and Green Growth). Article 174 of this law requires the government to present an annual

report to the Parliament which "quantifies and analyses public finance, assesses private finance, and measures their adequacy with the financial requirements to achieve the objective and transition pace of the law", whereas Article 173 obliges institutional investors to report on how they account for environmental, social and corporate governance (ESG) criteria, with specific mention of climate, in their investment policies. It also asks them to set out how they contribute to the low-carbon energy transition and other environmental objectives. However, questions were raised about the lack of standardization across banks on an aggregated level.

In France, the I4CE reports on climate investments, of which energy efficiency investments are an important part, since investments reveal most about future emissions (or energy efficiency). I4CE has conducted an annual study since 2014 on climate investments and funding patterns, and later added climate investment needs, fossil investments, and a funding plan to close the investment gap. In 2021 the scope was limited to climate investments, climate investment needs and fossil investments, to increase the level of detail, and assess the impact of the COVID-19 crisis.

To understand the funding patterns, a landscape of climate investments (similar to the other landscapes) was published in 2018, but it was not continued, because it faced several issues: inadequate rules of accounting (e.g. mixing stocks and flows), contradictory data (mixing loans and refinancing) and insufficient coverage.

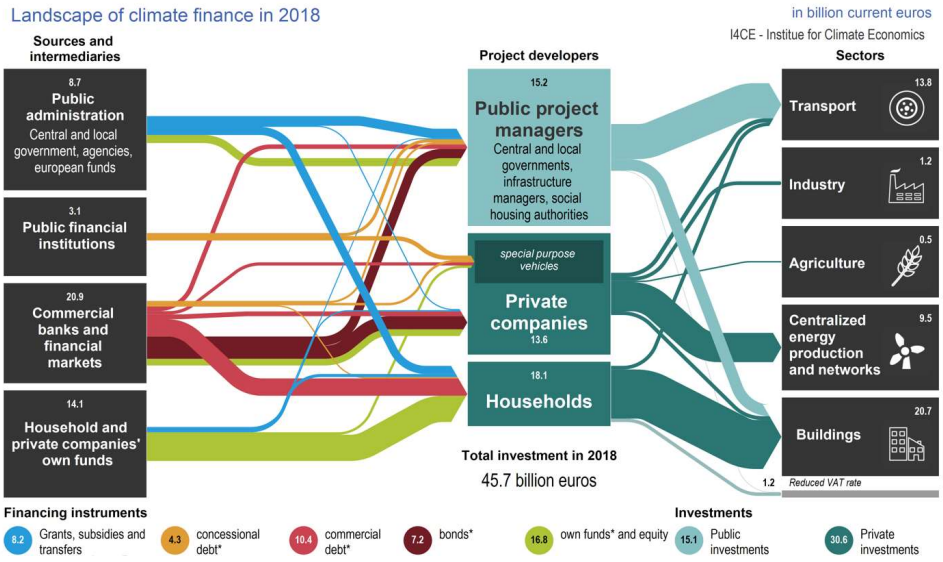


Figure 27: French landscape of climate finance, 2018

While France is maybe a role model in terms of data availability, there remain some issues in its methodology:

- Inadequate accounting approaches: it turned out that the reports' figures were mixing stocks and flows (e.g.: balance sheet equity, outstanding loans vs. investment, subsidies, new loans);

- Contradictory data: reports from banks frequently mix new loans and refinancing (in some sectors, loans were higher than total investment);

- Coverage: much-debated public subsidies to renewable power producers were not included.

Research papers are regularly published describing the landscapes produced by various organizations, but raw data is not always published. However, e.g. at the CPI website, downloadable datasets[53] are provided to some extent, as shown in the example shown here:

Western Europe region includes: Aland Islands, Andorra, Austria, Belgium, Czech Republic, Denmark, European Union, Faroe Islands, Finland, France, Germany, Gibraltar, Greece, Greenland, Guernsey, Iceland, Ireland, Isle of Man, Italy, Jersey, Liechtenstein, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Svalbard and Jan Mayen, Sweden, Switzerland, United Kingdom, and Vatican City. All figures in millions USD.

Actor level 1	Actor level 2	Financial Instrument							Grand Total
		Balance sheet financing (debt portion)	Balance sheet financing (equity portion)	Grant	Low-cost project debt	Project-level equity	Project-level market rate debt	Unknown	
2017									
Annual Total		**18.316**	**17.039**	**1.377**	**750**	**4.965**	**23.154**	**29.907**	**95.508**
Private		**13.834**	**15.279**	**0**		**3.208**	**6.554**		**38.875**
	Commercial FIs	292	29			340	5.273		**5.934**
	Corporations	12.961	8.299			2.381	211		**23.852**
	Funds	146	103			310	13		**571**
	Households & individuals		6.684						**6.684**
	Institutional investors	435	165	0		177	1.057		**1.834**
Public		**4.482**	**1.760**	**1.376**	**750**	**1.757**	**16.600**	**29.907**	**56.633**
	Bilateral DFIs						132		**132**
	Government & Agencies	553	228	1.375	10	503	0		**2.668**
	Multilateral Climate Funds			1		40			**41**
	Multilateral DFIs				740	888	15.417		**17.046**

53 https://www.climatepolicyinitiative.org/wp-content/uploads/2022/01/2019-2020_GLCF_Data.xlsx

	National DFIs					280	64	29.907	**30.250**
	Public Funds						39		**39**
	State-owned Entities	3.929	1.532			28	43		**5.533**
	State-owned FIs					19	904		**923**
2018									
Annual Total		**13.610**	**22.386**	**2.005**	**11.070**	**5.817**	**18.940**	**27.446**	**101.275**
Private		**11.894**	**21.372**			**4.641**	**12.066**		**49.973**
	Commercial FI	764	2			203	11.733		**12.701**
	Corporation	10.028	10.520			2.914	82		**23.543**
	Funds	848	445			1.392	71		**2.756**
	Households/individuals		10.280						**10.280**
	Institutional investors	255	126			132	180		**693**
Public		**1.715**	**1.014**	**2.005**	**11.070**	**1.176**	**6.875**	**27.446**	**51.301**
	Bilateral DFIs					168	154	1.324	**1.646**
	Export Credit Agencies						843		**843**
	Government & Agencies		279	1.988	14	8	38		**2.328**
	Multilateral Climate Funds			0					**0**
	Multilateral DFIs			17	11.056	628	3.425	70	**15.196**
	National DFIs						110	26.052	**26.162**
	Public Funds						9		**9**
	State-owned Entities	1.715	735			371			**2.821**
	State-owned FIs						2.296		**2.296**
Biennial Average 2017-2018									
Total		**15.963**	**19.713**	**1.691**	**5.910**	**5.391**	**21.047**	**28.676**	**98.391**
Private		**12.864**	**18.326**	**0**		**3.924**	**9.310**		**44.424**

	Commercial FI	528	15			271	8.503		**9.318**
	Corporation	11.495	9.409			2.647	147		**23.698**
	Funds	497	274			851	42		**1.663**
	Households/individuals		8.482						**8.482**
	Institutional investors	345	146	0		155	618		**1.263**
Public		**3.099**	**1.387**	**1.691**	**5.910**	**1.467**	**11.738**	**28.676**	**53.967**
	Bilateral DFIs					84	143	662	**889**
	Export Credit Agencies						421		**421**
	Government & Agencies	276	253	1.682	12	255	19		**2.498**
	Multilateral Climate Funds			1		20			**21**
	Multilateral DFIs			8	5.898	758	9.421	35	**16.121**
	National DFIs					140	87	27.979	**28.206**
	Public Funds						24		**24**
	State-owned Entities	2.822	1.133			200	22		**4.177**
	State-owned FIs					9	1.600		**1.610**
***Note that some totals will not match across tables due to data aggregation issues associated with crosstabbing.**									

Table 11: Excerpt of downloadable data. Source: Climate Policy Initiative

	Summary of the core data provided by the various climate finance landscapes
Governance	Performed by various organizations, which run the country-specific landscapes (CPI Global, I4CE, IKEM etc.)
Data architecture	Depends on data sources, i.e. rather diverse across different jurisdictions and organizations creating climate finance landscapes.
Integrity	Ensured by the producing NGO or research organization. Results published in academic papers can be assumed to be up to the respective academic standards.
Completeness	Country-specific and methodology dependent. So far not all EU Member States have been covered.

Timeliness	Landscapes are updated with some regularity, but depends on funding for these projects.
Adaptability	Methodology varies across the different landscape-producing organizations and is typically adaptable to the needs when necessary.
Accuracy	Assumptions and projections are involved in the process of creating the landscapes, final accuracy hard to judge.
Comprehensiveness	Within a jurisdiction, a high comprehensiveness can be achieved, but methodological challenges can arise (see France), investments in energy efficiency directly considered.
Clarity	The presentation as a landscape with financial flows provides a high level of clarity.
Frequency	Update frequency depends on country.
Distribution	Distributed as reports with some detailed tables.
Review	No external review is performed, except if published in an academic journal.

3.2.9 Advanced methods

In this section, the **upcoming AI and machine learning approaches to filling the data gaps** that have been identified by financial institutions working with incomplete data at MS level in the building sector are described.

SkenData

SkenData is a German technology company providing valuation, land tax, and energy services in the German and Austrian market. Their technology is based on creating digital twins for the whole building stock of a country, by combining data from various data sources, including the envelope, as well as installations within the building.

Using that approach, the major advantage is that the whole building stock pre-exists as digital twins already in a database, e.g. the whole building stock (including garages) for Germany (52 Mio.) and Austria (3.0 Mio) is covered by the tool. For Germany the tool had been set-up on an already existing 3D model, while for Austria the model had to be produced by SkenData, which took six months to produce. However, the next country would be faster, especially if that country already has a digital model of its building stock. The generation of the digital models is driven by satellite images. Overall, the technology covers residential buildings, office buildings and buildings with mixed residential and commercial use are covered, while purely commercially used buildings are not covered and that a portfolio assessment of those is more complicated.

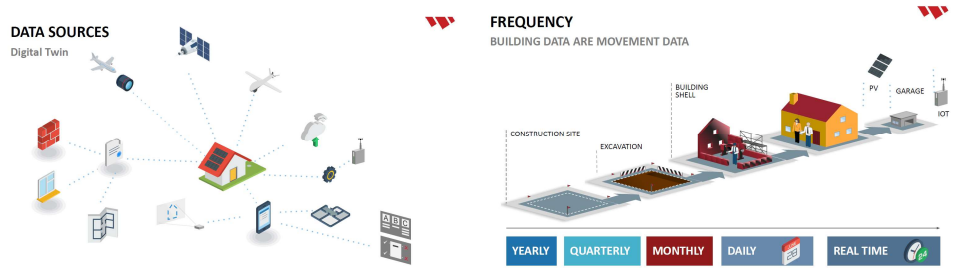


Figure 28: Data sources for the SkenData approach

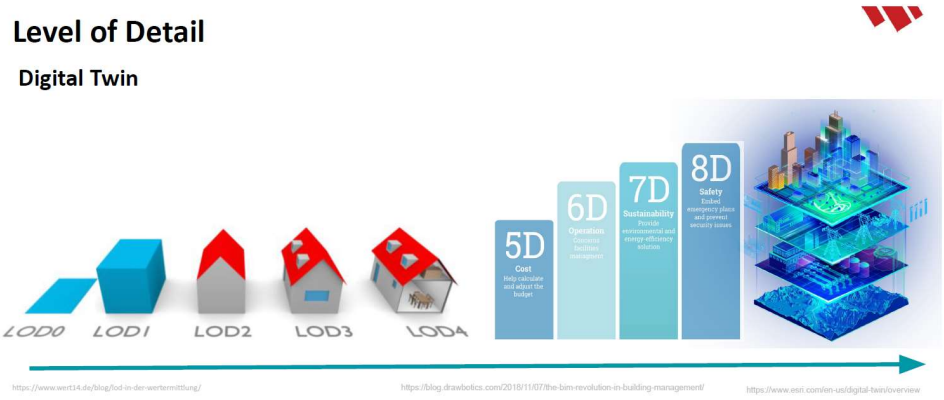


Figure 29: Level of detail in the SkenData approach

SkenData's technology follows an event-driven data mesh approach and provides monthly and yearly refreshes (depending on the data source), which allows it to track changes to buildings over time. For example, this tool compares monthly satellite images and automatically detects changes by comparing both images. As an example, this can be used to detect new photo-voltaic (PV) installations or renovation works.

The high level of detail (digital twin) allows to calculate energy efficiency related Key Performance Indicators (KPIs), e.g. energy demand and GHG emission, with a much higher accuracy than other methods. Following the official guidelines on calculations procedures for Energy Performance Certificates (EPCs), new EPCs can be issued using that technology. This solution is replicable and can be scaled up to include more EU Member States in the future.

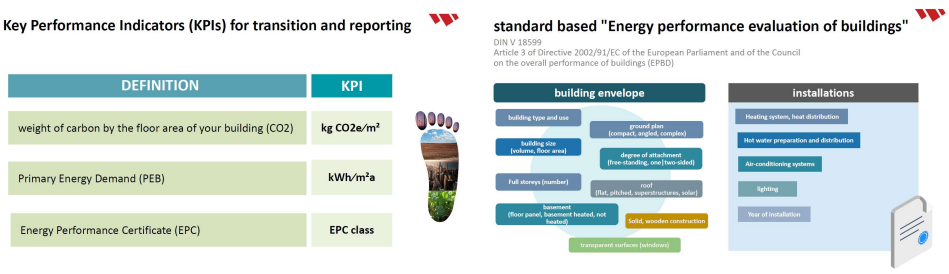


Figure 30: Key performance indicators available in the SkenData approach

The SkenData solution can upload a list of client addresses and the system then retrieves the corresponding data from the digital twin. With the only input being

the address of a building, the online dashboard shows various KPIs (including the EPC rating, the primary energy demand, CO_2 equivalent emissions) and a satellite image of the building, as illustrated here:

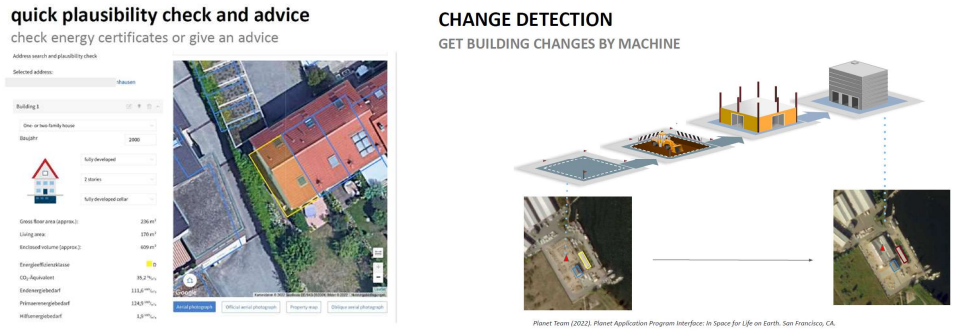


Figure 31: Outline of the SkenData user interface and automated change detection

The digital twin of the building can be refined, where necessary, e.g. by changing the roof shape, or by entering the year of construction. This helps to produce more accurate results. The default mode calculation is purely based on the address, which should be treated as a first guess, but when more information is added, the tool can provide official EPC certificates, compliant with e.g. the German DIN 18599 standard. The current assessment of accuracy for the purely address-based estimate is ±1 EPC classes.

The results are exported with additional information compared to the dashboard, e.g. the rebuilding costs, or a flood risk category. As a back-testing example, the EPC ratings from other commercial tools were compared to the result of SkenData's tool and the results differ by no more than one EPC class. In the future, this can be combined with a price calculation of what the owner would have to pay to reach a certain EPC rating for a certain building. This method is based on KfW's tool to assess modernization costs.

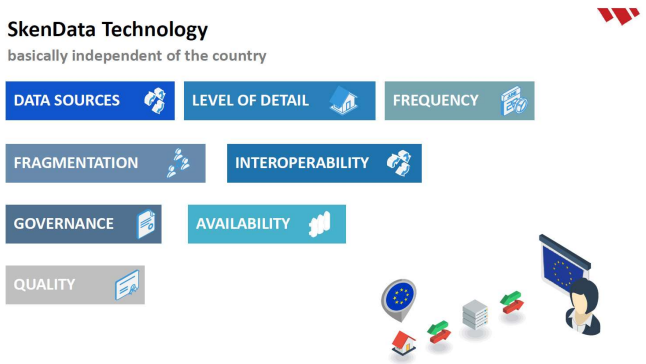


Figure 32 Interoperability of the SkenData approach

In summary, the technology described by SkenData might provide a first example of an advanced, scalable approach that allows to fully assess the European building stock in terms energy efficiency, allowing for identifying the most cost efficient and climate effective way for renovations Europe.

Automated assessment of energy efficiency and renovation costs

SkenData's technology allows for identifying buildings individually and to calculate their ESG KPIs including energy efficiency properties. Additionally, and based on these KPIs, an individual estimate renovation roadmap (iSFP) can be created automatically using the SkenData calculation technology. The iSFP refers in particular to the improvement of the building's energy efficiency status. The improvements can be subdivided into different measures, e.g. for changing building elements such as roof, exterior walls, interior walls, doors, windows, heating, plumbing, electrical installation and additional equipment such as solar technology.

The implementation of such a measure leads to a change in KPIs such as EPC and CO_2 emission. Each measure is automatically assessed with respect to its impact on the KPIs as well as from the cost side and the payback time. For costs, a reference is made to current energy prices and individual consumption. The new technology enables an unprecedented scenario diversity and speed for decision making.

Overall, such a technology can provide a major lever for meeting the Commission's objectives, as one could image performing an AI / satellite "scan" of the European building stock in terms of energy efficiency in the future and enriching that data set with a cost estimate for bringing it to a certain target level. That would provide a good estimate for the overall investment need in Europe, given a certain target level.

	Summary of the core data provided by SkenData
Governance	Governance provided by the developing company.
Data architecture	Flexible data mesh for fast feature development.
Integrity	Integrity is ensured by automated data quality (DQ) checks.
Completeness	Full completeness can be achieved fast by pre-listing the full building stock of countries.
Timeliness	Short-term updates possible, e.g. on monthly basis.
Adaptability	High adaptability due to advanced technologies.
Accuracy	In-line with official standards e.g. for deriving energy efficiency classes (EPC).
Comprehensiveness	Full comprehensiveness on country-level in terms of energy efficiency, investment needs can be added via a separate tool (e.g. renovation calculators).
Clarity	User-friendly online tool.
Frequency	High update frequencies possible.
Distribution	Via commercial application programming interface (API).
Review	Similar methodology is used for official tax calculations, therefore high external scrutiny.

Sociedad de Tasación

As a response to the increasing sustainability reporting requirements on European financial institutions, the Spanish valuation company Sociedad de Tasación (ST) - with 36 years of experience in real estate - has developed an **AI-machine learning data analytics tool to estimate the energy performance and climate risks of mortgage portfolios**. While in Spain the property owner is responsible for getting an Energy Performance Certificate (EPC), this information is not easily transferred to the lenders. Therefore, the ST tool aims to provide banks with the necessary information to align with Europe's supervisory expectations, assess the risks inherent in their portfolios, and build the path towards greening their mortgages.

The process to build this tool began in 2019, when ST decided to collect Environmental, Social and Governance (ESG) data from loan collateral with the ultimate objective of including ESG in valuations. In 2021 the European Banking Authority (EBA) published its Report on Management and Supervision of ESG risks for credit institutions and investment firms, which pointed at the issue of ensuring that banks get the necessary data on the performance of their mortgage portfolios, acknowledging the **need to use models and estimations where no reliable data is available**. These supervisory expectations set the path for ST to begin building its EPC and climate risks tool.

Based on the EBA guidelines, ST has developed a **3-step working methodology** for properties that 1) identifies the impact of properties on the climate and vice versa (transition and physical risks), 2) qualifies the risks based on a data-based model and 3) assesses the energy performance and risk exposure of the property.

Figure 33: ST's 3 step working methodology

This AI cascade-based tool relies on **a public cadastral database that provides the energy performance of four million properties and ST's own databases** that provide information like the construction year of the building, the climatic location, the renovation code, etc. An **estimation model is then used to fill in the gap for the rest of 22 million properties** that lack publicly-available energy performance data, with a follow-up back-testing that has been carried out in the city of Barcelona. One of the challenges that arose in this process was that not all Autonomous Communities are collecting the same information on buildings, so ST had to homogenize the information from public registries in each Community. ST then developed three different models based on the dispersion available and the volume of certificates available that, by looking into the building, can **infer the EPC letter of a particular asset.**

The cadastral database used serves as an inventory and, due to its deviations, the data is compared with ST's appraisals. The valuation process of a building provides characteristics that can be proportionally applied to the rest of the building stock at the individual asset level. In the absence of data from appraisals, ST's model uses the cadastral database. The ST tool **works at the street and building level** and it can identify, based on the shapes of street maps, what buildings have similar characteristics, to then infer their energy performance.

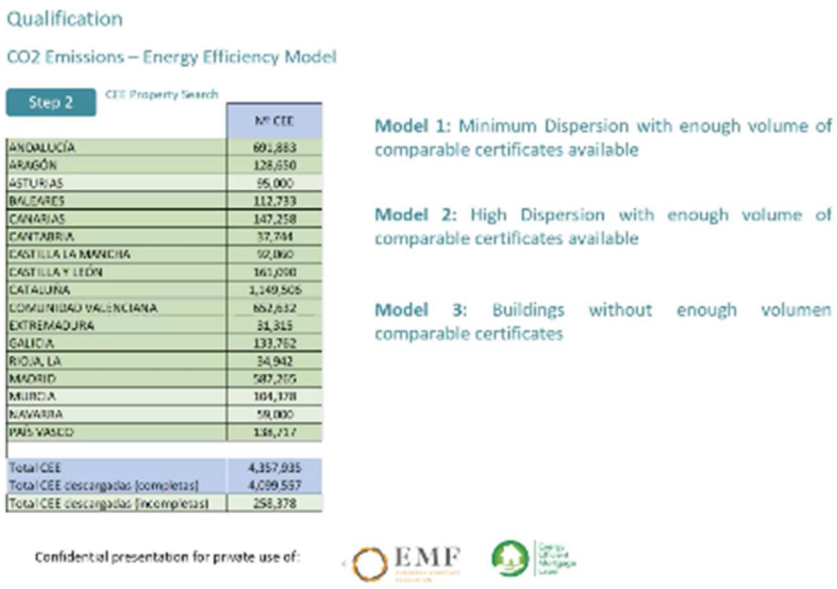


Figure 34: screenshot of ST's databases and models

The **back-testing carried out in Barcelona used 300,000 EPCs and energy bills** and it delivered positive, reliable results in line with the ECB's expectations. The model can be scrutinized and **audited by an external party** as per the recommendations of the EBA.

A total of **47 financial institutions in Spain have already undergone ST's data analysis exercise** and the tool has been presented to the Bank of Spain and an auditor. It provides information in a visual way for lenders, segmented by variables at the lowest scale as preferred (per city, at the municipal level, and it can even compare different properties). If the EPC of an asset is available, then the tool provides it together with data on emissions and consumption. If the certificate doesn't exist then the tool runs the model to estimate the EPC.

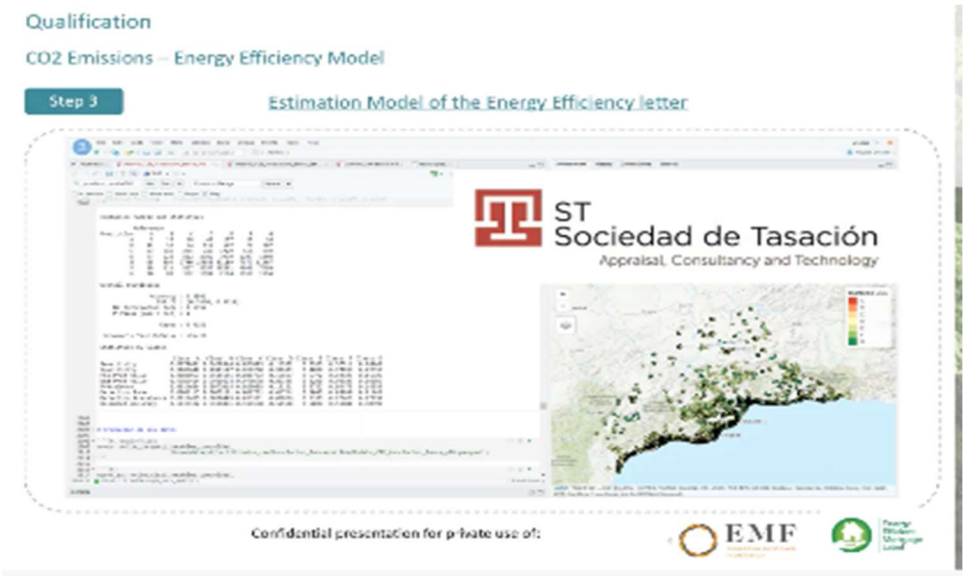


Figure 35: screenshot of ST's estimation model

Physical risks are also included in ST's tool, as per the supervisory expectations. ST has correlated the information from authorities to the cadastral information. In the same platform it is possible for the lender to view the EPCs (real or model-based) and the physical risks associated with the cadastral unit - **also at individual asset level**.

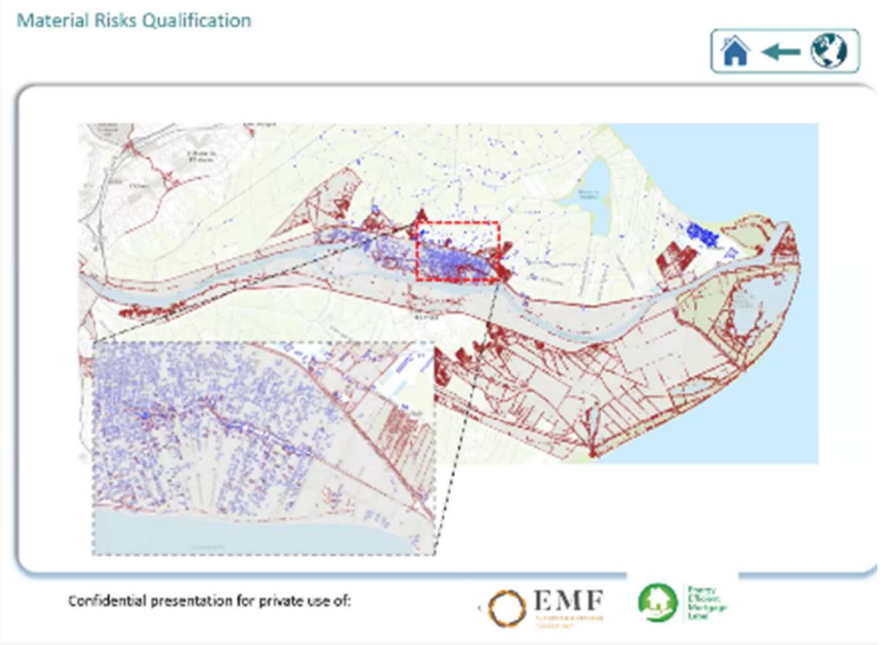


Figure 36: screenshot of ST's material risks qualification model

ST hasn't entered yet in the quantification of the effects due to exposure, as this is not yet within the EBA supervisory expectations. Applications of the information are currently being used with a historical portfolio analysis, but **a proactive approach is being developed**. For instance, every time a request for a new mortgage is raised, the tool could provide the financial institution with the real information on real time through API exchange of information for its decision-making.

Some banks are already taking the next step and using ST's tool for segmenting and prioritizing Next Generation EU funds. The tool provides information about the effort needed to renovate buildings in a cost-effective way. The model can evaluate a particular asset to understand whether it is a client of the bank and the loan to value needed to provide credit for greening that house.

	Summary of the data provided by Sociedad de Tasación
Governance	ST's internal programmers, management team and bank users. In addition, external regulatory input has been sought.
Data architecture	Designed to deliver against the EBA's requirements for identification of climate risks in real estate lending collateral and replicating EPC and registry data structures.
Integrity	Statistical tests to ensure alignment with real observations.
Completeness	Framed to be complete within the frame of financial regulation for the identification of risks.
Timeliness	Availability by paid access online with data updated constantly in real-time subject to resources.

Adaptability	ST constantly adapting to best practices and updates in the regulations.
Accuracy	Incorporates all available real data (4 million EPCs) and back-tests estimates against real data where available, deploying three statistical model types in cases of low real data points.
Comprehensiveness	Comprehensive in the context of the lender's regulatory frame.
Clarity	Clearly shown with graphical outputs.
Frequency	Updated on an ongoing basis subject to resources.
Distribution	Available online and used by 47 finance players in Spain, limited by internal ST marketing resources.
Review	Expert internal review and presentations to regulators and auditors.

3.3 Assessment of currently available datasets and their limitations

In order to come up with sound assessment of the current datasets, in particular regarding their limitations, and to evaluate potential ways to improve the current situation, the Working Group conducted a survey among its members, using the assessment framework outlined in section 3.1.1. Fifteen members of this Working Group provided their expert opinion in this survey. The results of this survey and the resulting overall assessment are provided in the following sections.

3.3.1 Framing Questions

A major task of the Working Group was to shed light on some of the fundamental issues for collecting and monitoring data on investments in energy efficiency measures. The survey provides some clear consensus insights into these issues.

73% of the respondents think that the data needs of the European Commission in terms of energy efficiency investments cannot be met by existing datasets.

Various reasons were cited for this particular assessment: First, **there is no existing database that covers all relevant fields while, at the same time, covering a broad set of countries or branches**. Furthermore, the situation on availability of data differs between Member States, hence without a standardisation of datasets that need to be monitored, one cannot expect to have comparable results, which may lead to wrong conclusions (e.g. that energy efficiency investments are much smaller or larger than they are in reality).

Second, the **data landscape in Europe on energy efficiency investments is highly fragmented with inconsistent definitions, scopes, and objectives**. Even after the work of this Working Group, consistent activities are required as a minimum to maintain and further expand the list of datasets and the collation of the data from various sources. For example, the potential for using real (smart

meter) data is largely unexploited, e.g. metered energy consumption, own investments, investments in renovation of public buildings. A lot of data might not be registered anywhere and therefore lost. Collecting and monitoring real data is of critical importance to connect the EC policies with reality.

Third, the respondents also mentioned **a lack of standardization**: The majority of the currently available datasets are based on deemed performance, often using not fully clear and comparable methodologies for evaluation. There is a lack of basic statistics on building energy efficiency measures being invested in, with even the EPCs across MS not being consistent or not having any open access mechanisms. Additionally, there is a lack of digital and "processable" data and a lack of consideration of the final aim when defining an investment (e.g. is the measure in question part of a feasible overall strategy which meets the goal).

Only 53% of the respondents think that it is possible – with reasonable effort – to integrate existing data sources into a coherent dataset for the purpose of the European Commission to monitor public and private energy efficiency investment.

On one hand, it was mentioned that simple Eurostat reporting mechanisms can be used to create templates for regular reporting, with national statistical authorities supporting this collection. Furthermore, the IEA has developed an estimation methodology for a decade and this provides a good template for EU to follow to get "high level" data sufficient for policymakers. Additionally, the current work from the EC and bodies such as UNEP Global Alliance for Buildings and Construction (GABC) on digital building passports or logbooks can help to implement an efficient and effective data collection. But in general, a **clear guidance is required on what to collect and how to report** in order to keep efforts in check. For example, using regulation and standards the EU could establish an initial framework for the reporting of key high-level data.

On the other hand, it was argued that **the available data currently is too distributed and too different in structure to be combined into an accurate picture**. Thus, **the effort itself required to integrate them, if successful at all, would be excessively high**. In particular due to the fragmented nature of the data at the moment, integration is impossible without major changes on how things are collected. Integrating existing datasets might also fall short of the new types of data which might need to be collected, such as data on energy efficiency loans from financial institutions.

Only 47% of the respondents think that data collection at the EU Member State level exists, which could serve as a blueprint for the European Commission to collect data on energy efficiency investments.

Building upon an existing data collection would strongly reduce the development time and the project risk of setting a European data collection. The Working Group members highlighted the following options:

First, article 7 of the EED can be a powerful tool to collect data on energy efficiency investments, as it brings about the obligation to report on achieved energy savings by alternative measures or suppliers' obligation scheme. For that purpose, there are data bases of implemented measures, e.g. **Austrian Monitoringstelle**[54] as a relevant example. Data about implemented projects and related investments could be collected through such systems. However, currently the **standardisation of datasets to be collected on EU level is missing and they are typically not set up to share financial data externally**. But **in terms of collecting the energy savings data, the EED data is a highly recommended source of data on energy savings.** Ideally, the EED data owners would be encouraged or obliged to share specific financial data in addition.

Provisions for encouraging data exchange can also be found in article 14 of the EPBD recast, which states that owners, tenants, and managers shall have access to a comprehensive set of building-related data, while at the same time allowing for public access to aggregated and anonymised building data. These provisions include sharing information from national databases to the EU BSO on a regular basis. It will be crucial to implement such rules in a practical manner, and ideally include financial data as well.

Second, data collections that collect granular, e.g. project-based, data on investments and energy efficiency gains like DEEP, EN-TRACK, etc. could serve as blueprint, although they are limited to certain sectors, e.g. buildings at the moment.

Third, Ireland has collected a significant amount of investment data for its various grants, similar to other Member States. Similarly, the UK's energy efficiency statistics and (most relevant) the National Energy Efficiency Data Framework provides a good template for others for the buildings side. However, outside of government schemes it does not collect energy efficiency investment data.

Illustration of Energy Efficiency Investment Data: One of the largest recent studies of actual retrofit energy savings, using real measured whole-home energy use data, was published in December 2021 and covers over 8,500 non-social houses in Ireland. The study shows an average energy use reduction of 1,091 kWh/year, which is just 10% of the 11,000 kWh of gas used annually by the average Irish home, and was worth around €65/year in 2021 Irish gas prices. At a cost of €4,276 per retrofit, with on average €1,200 of grant subsidy, these renovations are expected to payback homeowner investments in over 40 years. Clearly the cost reductions from energy savings alone were not the sole motivating factors for these Irish homeowners.

Last but not least, some of the datasets more specifically assessed by the Working Group like the methodologies presented by IKEM, I4CE and OPERAT

54 https://www.monitoringstelle.at

from Ademe have been mentioned as good blueprints for collection data on energy efficiency investments.

The two key issues with current data collections are: a) too narrow scope and b) the lack of a clear definition of what actually constitutes an investment in energy efficiency.

It became apparent here that **there is hardly any database that connects energy efficiency information with investment volumes on a broader scope**. Additionally, there are many energy efficiency investments that are happening outside of any 'system' (e.g. without state support or outside Energy Efficiency Obligation Schemes (EEOS) or without FI Loans), which are poorly captured currently like e.g. private investments in energy efficiency improvements. Due to different definitions and methods, there is clear lack of comparability of the currently generated data.

The biggest shortcomings in terms of data availability are clearly seen in SMEs and industrial sector as well as for residential buildings. Commercial and public buildings are less of an issue.

A lot focus has been on collecting EPC data for buildings, by many actors, but in particular several European projects have started tackling the data challenge in the real estate sector. DEEP and EN-TRACK are prominent examples of those. Obviously, complexity regarding investments in energy efficiency is far greater in the SMEs and larger industrial companies, as well as for the broad scale of residential buildings where data sharing obligations are less easily enforced.

For buildings, there is definite number of products which are used to improve the energy efficiency, e.g. heat-pumps, insulation materials etc. Those products can be tracked based on either their sales by trading companies or usage data on project level. In contrast in the industrial sector, be it small or large, the energy efficiency depends to a large extent on the manufacturing and production processes. This requires far more specific information than what is typically available.

The exact definition of what constitutes an energy efficiency investment is still under debate.

One definition of an investment in energy efficiency could be "any money spent on investments that improve energy performance, shall be counted as an energy efficiency investment". This definition might be general enough as it was perceived as difficult to dissect the intention behind an investment in a product, which on one hand reduces energy consumption, but on the other hand also e.g. increases productivity like a more modern production machine.

While in some sense it would be ideal to only account for avoidable energy efficiency investments, it is by far easier to measure any energy investments as compared to distinguishing between avoidable and inevitable energy efficiency investments. Still, 'energy performance' needs to be then clearly defined. Also, with this definition, there will be an issue with 'additionality' of savings required

by EED, which can be perceived as more 'academic' than practical. Additionally, an alignment with the EU Taxonomy, the EU-wide classification system for sustainable activities, also requires significant improvements.

Another specific issue to be resolved refers to the question how to treat reoccurring e.g. annual investments for an energy system like building maintenance or regular repairs. It needs to be clarified whether they should be included or not, depending on their impact on energy efficiency. For some applications it might be useful to know whether investments are occurring only because of an upgrade imperative e.g. driven by regulatory requirements. Overall, there is a need to make a trade-off between covering all corner cases and a generally applicable and feasible definition.

3.3.2 Assessment of individual datasets

BCBS 239 is a well-established framework in the banking sectors that is used to ensure appropriate data aggregation capabilities in the financial sector. This framework has been adapted by the Working Group to be applied to ranking sources and methods for collecting and monitoring data on energy efficiency investments along 12 relevant dimensions. There has been a broad agreement that this approach is suitable for providing assessment of those datasets and methods, which have been reviewed in more detail.

80% of the WG respondents agree with using the BCBS239-derived framework for assessing the suitability of the datasets specifically reviewed.

In the survey, Working Members used that framework to rank the data sources and methods, as implemented by a range of providers, on a scale from "Strong (4)", "Quite strong (3)", "Fairly weak (2)" and "Weak (1)" for each of the dimensions. The resulting average assessment can be found in the matrix shown in Figure 37.

		BCBS criteria												Overall assessment
		Governance	Data and IT infrastructure	Accuracy and Integrity	Completeness	Timeliness	Adaptability	Accuracy	Comprehensiveness	Clarity and usefulness	Frequency	Distribution and accessibility	Review	
Data sources considered	EIB Investment Survey	3,2	3,0	3,3	3,5	3,3	3,3	3,2	3,0	3,3	3,3	2,6	3,3	3,2
	SkenData	2,5	3,8	3,0	2,8	4,0	3,8	2,8	2,8	3,8	3,8	2,3	1,8	3,1
	Sociedad de Tasacion	2,5	3,8	3,0	2,8	4,0	3,8	2,8	2,8	3,8	3,8	2,3	1,8	3,1
	Eurostat	3,5	3,4	3,0	2,9	2,6	2,0	3,1	2,7	2,8	2,6	3,6	3,5	3,0
	IEA	3,0	2,8	2,4	2,8	3,1	3,0	2,6	3,0	3,3	3,1	2,6	3,0	2,9
	Odyssee-Mure	2,9	3,0	2,7	2,9	2,9	2,3	3,1	2,7	3,1	2,7	2,6	3,2	2,8
	DEEP	3,0	3,4	3,2	2,6	2,4	2,8	3,0	2,4	2,8	2,4	3,0	3,0	2,8
	Operat	2,7	3,0	3,3	2,3	2,7	2,3	3,0	2,3	2,7	2,7	2,7	2,7	2,7

Figure 37: Assessment of identified datasets by survey respondents. The colours indicate a positive (green), medium (amber) or less positive assessment (red) of how well these data sources would fit to the mission of the tracking investments into energy efficiency.

Based on the consensus expert opinion, the overall assessment clearly shows a preference for the approaches presented by the EIB Investment Survey, augmented by modern approaches like proposed by SkenData and Sociedad de Tasacion, as well as IEA's and Eurostat's approach. But it is also clear that the current approaches have different patterns of advantages and disadvantages across the data dimensions.

For example, as a rather classical survey methodology, the EIBIS has received good assessments across the board. The IEA's approach has received rather similar assessment, although slightly lower and with one notable exception: there are obviously some doubts about the accuracy of the results, which might result from a hesitation of the IEA to fully share details on source data and detailed methodology beyond what is published.

When comparing the assessment of Eurostat with e.g. the modern approaches driven by private companies (SkenData and Sociedad de Tasacion), a notable pattern is emerging: the approach of Eurostat received a low assessment in the dimension of adaptability, whereas the modern approaches get high scores exactly for adaptability, timeliness, clarity, and frequency. On the opposite side, Eurostat is stronger on the dimensions of governance and review. So there seems to be a complementarity between a highly structured, but slow process on the Eurostat side and the more agile, but less strongly governed approach of

the private companies. **In an ideal world, one could combine these relative strengths and enable private companies to contribute data to the European data universe that is more adaptable than current efforts driven by governments.**

With respect to the importance and potential for the EC's data strategy, energy agencies, the EC's collaboration with EU Member State ministries and public development banks is deemed most crucial.

Given the formidable task of aligning multiple stakeholders across Member States that assessment clearly highlights the role of the public sector for achieving the objective. Clarity on the requirements in a legal sense and the definitory power of European and national authorities can only be achieved by the public sector taking the lead in defining the requirements, thereby achieving a consistency, which multiple private initiatives might not be able to achieve. Ideally, one can utilize the higher agility and user focus of the private sector complementary to public sector initiatives, which can provide guidance and governance. A suitable data sharing platform, which implements commonly agreed definition of data would greatly facilitate the implementation of a European solution with strengths across all data dimensions.

	Industry data	SME data	Buildings data	Data partner for EC
Energy agencies	3,3	3,1	3,3	3,9
EU Member State ministries	3,6	3,3	3,4	3,7
Multilaterals/IFIs/Development Banks	3,3	2,7	3,0	3,5
Lenders/FIs	3,0	3,1	3,3	3,3
Machine learning/AI	2,6	2,4	3,3	3,3
International organisations	2,8	2,9	2,4	3,3
Regional and municipal authorities	2,3	2,4	3,3	3,2
Research institutes & consultancies	3,1	3,1	3,1	3,1
EU projects	2,8	2,8	2,9	3,1
Associations	3,4	2,6	2,6	3,0
NGOs/think tanks	2,3	2,3	2,7	2,9
Market research companies	2,9	2,6	2,3	2,6
Media	1,6	1,1	1,3	1,3

Figure 38 Ranking of data partners and sources

Overall, the quality of the data depends on the schemes the national authorities provide. For example, IEA does not have much SME data, but they have recently launched an energy audit support and are planning an SME grant. The IEA will thus soon have a lot of investment data for SMEs which is hopefully shared with other stakeholders as well.

The Working Group's experts recommended to consider additional sources, e.g. commercial data providers like Bloomberg, ESG rating agencies and other data providers to financial institutions, opinion surveys like e.g. ad hoc Eurobarometer's Flash surveys targeting a specific topic, e.g. on drivers and barriers of investing in energy efficiency.

3.3.3 Potential solutions

Given the fundamental issues mentioned above, the major question will be on how to resolve these issues. First of all, who should drive those initiatives?

60% of the respondents think that the European Commission should start its own data aggregation or collection.

A data collection initiated and driven by the European Commission provides several advantages, although this may require adequate resources at the Commission, including data modelers and a data scientist:

It would allow to achieve a consistent picture of the state of play regarding energy efficiency investments by setting the right kind of standards and definitions. Centralized data collections can be adapted more easily than decentralized ones. Furthermore, the Commission could tailor the data collection exactly to its actual needs for decision making.

However, the impact would also depend on the implementation time. In case for example, a full-scale implementation would take too long for delivering timely input, a good intermediate solution would be to gather data based on existing solution, e.g. by extending the EIB Investment Survey. A survey of households and businesses, incl. large real estate owners on energy efficiency expenditure would support decision making on the short term.

Instrumenting a survey would avoid a continuation of ad hoc or intermittent data collection and better ensure the scope is covered. There are costs and the additional provision of guides and reporting procedures for a variety of organizations will ensure consistency and harmonization are possible. Further, increasing the reporting mechanisms for products sold and labels changed will give a more comprehensive overview of the investment landscape. Finally, compelling regulated industries to report (at least) top level lines will ensure data is available to track change in investments. In the medium or long-term, a solution driven by Eurostat would be of course preferable, in particular when data is collected via the national statistics offices.

Overall, any redundancy in data collection should be kept to a minimum. Since the Member States already have obligations, the set of data to be collected should be defined and an obligatory reporting established (such as within their reporting on achievement of NECP targets), in order not to impose new stand-alone reporting obligations. It was noted that challenge is inherently decentralised and the solution has to be decentralised. The EU's role is to set the framework for data collection to allow consistency and read-across.

Existing data platforms such as EN-TRACK or ODYSSEE could be an option to speed up data collection. However, data gathering needs continuous effort and support and in particular clear governance policies. Here example from the US can provide useful insights, the EPA Energy Star tool[55] and the Building Performance Databases[56] are clear examples of standard approaches. Tools related to the recast of the EPBD, and in particular to the digital building passport, show very interesting results and can provide viable starting points for further developments.[57]

Dedicating full time resources to the task and potentially establishing an expert group to support and guide these resources may further improve and expedite the outcome, which is having the information in place for decision making on a reasonable time frame.

Accurately linking energy efficiency gains with the respective investments amounts is only possible on a granular level.

Beyond approximation solutions, energy efficiency and investment therein need to be tracked on a granular level (i.e. on building-, project- or product level), where both effect and price are recorded. For example, reporting on energy savings is obligatory through Art.7 of EED, so could envisage requesting an obligatory reporting on investments for achieved energy savings, which however will not cover all investment areas. It has been noted that a clear legal reason for that is required in order to ensure compliance, governance and execution.

67% of the respondents think that the IEA methodology could be a suitable starting point for a short-term solution.

Given with the issues of initiating a data collection on the short run, an approximation approach might still be highly valuable. Despite the reservation with regards to IEA methodology mentioned before, the IEA methodology still provides one of the most solid approaches to estimating energy efficiency investments. Such an approach would be most attractive when it is continuously improved, the methodology is disclosed and data is made available to third parties. The assessment is that the IEA method is sufficiently robust for policymakers, and it can be adapted for EU. Nevertheless, it should be avoided that short-term solutions hinder the development of a viable long-term solution.

60% of the respondents think that models based on Artificial Intelligence fill the gaps in the existing data collections.

Modern technologies allow the efficient processing and analysis of types of data, which were previously not accessible to automated analysis, like images, sound, or human languages. This is achieved by the application of new statistical methods called "artificial intelligence (AI)". For example, these methods can extract the full coverage of the European building stock from satellite images,

55 c.f. https://www.energystar.gov/buildings/benchmark

56 c.f. https://www.energy.gov/eere/buildings/building-performance-database-bpd

57 c.f. e.g. https://passport.stepwise.pl/

allowing to immediately create a database of all building at once, including even a classification into certain types of buildings. As long as there is a physical object, which can be scanned, identifying the required population (in a statistical sense) becomes much more efficient, even without any specific data collection from e.g. building owners.

Additionally, AI solutions can derive more accurate predictions of the energy efficiency of buildings, even when no real data is available. AI and machine learning can intelligently combine multiple overlapping data sources on buildings to provide reasonably accurate estimates of energy use and related investment needs. Naturally, AI models require sound validation in order to be reliable.

Therefore, artificial intelligence may also fill gaps in the data collection to some extend ("interpolation"). However, it mainly provides a means to approximate the energy efficiency and/or investments. In that sense it is an approximation method like all other approximation methods. Although it would be preferable to measure exact data to the extent possible, such methods might nevertheless be useful to provide more timely information.

For AI to be efficient and useful, the scope and the definitions of the AI must be clearly defined. One can only collect data once the definitions have been set and agreed for different data points. Of course, the optimal way to ensure investment data is being captured is to track it through reporting schemes, whether as point of sale or building data passport, or tax rebate/records.

4 Barriers and obstacles to accessibility and intelligibility of data

Within the banking sector, clear guidelines exist for making sure that data is collected, analysed, and aggregated using a sound and adequate data governance. The Basel Committee's BCBS 239 paper[58] is a landmark achievement in this regard and outlines these best practices in an authoritative manner. We recommend and use that framework here to define the goals as well as identify the current gaps of the collection of energy efficiency investment data at the EU level.

4.1 Conclusion from the analysis

Our analysis showed that there is very clearly no single dataset which can deliver on all of the EC's requirements in terms of scope and which currently delivers fully against the 12 best-practice data governance principles identified for financial institutions. The patchwork of datasets provides a partial view on the questions asked by the EC in the WG's terms of reference, but stitching the patches together is non-trivial. Surveys, modelling, estimations, AI and machine learning are emerging tools that can fill real data gaps and are used by IEA and financial institutions to provide answers.

4.1.1 What is missing?

It became apparent that the **crucial ingredient missing in most data collections examined is the linkage between energy efficiency and investment data**. To monitor the amount and impacts of energy efficiency investments we need to unequivocally link the two main datasets – on energy use and on energy-related investments – through a "primary key" (see Figure 39).

58 https://www.bis.org/publ/bcbs239.pdf

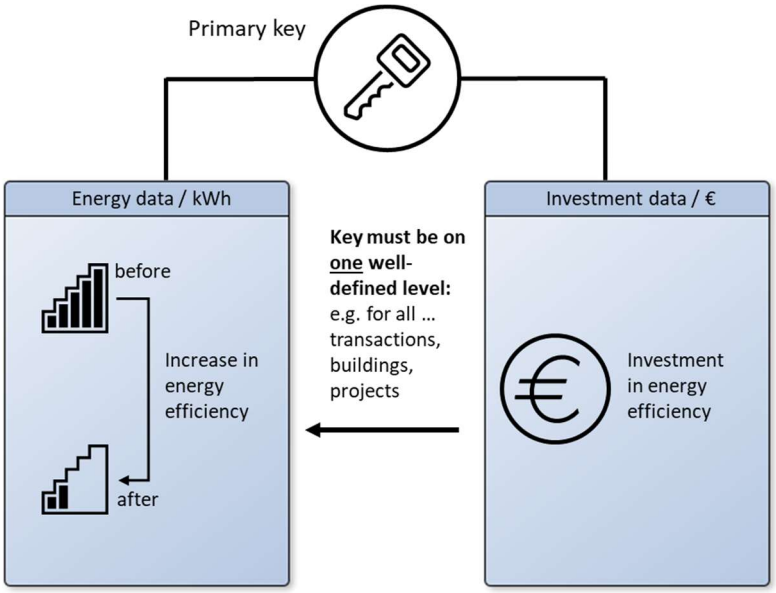


Figure 39 Target picture for linking energy and investment data

A primary key is a code that is assigned on well-defined level to objects, which are to be examined by the data collection method. More practically speaking, if the data's purpose is to provide a statistic on buildings, one would collect a list of all buildings, assign each building a unique code or key, and build a second table in parallel, which would contain e.g. the investments for each of the different buildings, each investment would be earmarked with the same unique key for the building it was invested in. This way a statistic on average energy efficiency investments per building or the total amount of all energy efficiency investments in buildings can be created. A similar exercise can be done for all deep renovation projects or to collect data on all energy efficiency investments of companies. This requires data collection frames with unique keys at a project level or on a company level, respectively.

4.1.2 Why is it an issue?

To collect high quality data on investments in energy efficiency, one needs to decide the level of granularity of data collection (e.g. on company level, building level, etc.), assign a primary or unique key at the asset level, and use that key to link investment data (in Euro) to energy data (in kWh). To finally assess the impact of any energy efficiency investment, the level of energy efficiency before and after the investment is required. In reality, only a very few of the datasets examined are able to make that link on a reasonable level of granularity, there are just two examples of this which are included below in Figure 40.

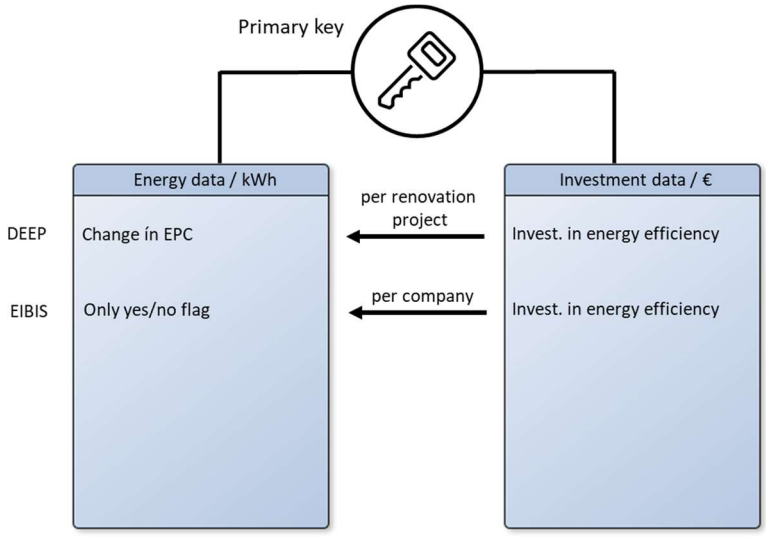


Figure 40: Only few datasets actually link energy and investments on some level

Even if a primary key exists within specific databases, the different level of granularity and design of the keys makes it difficult to aggregate information from different data collections. If we would – for example – try to use the OPERAT database, which contains information on energy efficiency gains on the level of individual buildings, to augment the missing energy efficiency data in the EIBIS, we could select a subset of companies from EIBIS, which are known to invest in renovations. But lacking a primary key, we don't know which company from EIBIS has invested in which building, so we cannot assess the energy savings achieved with the investments (see Figure 41).

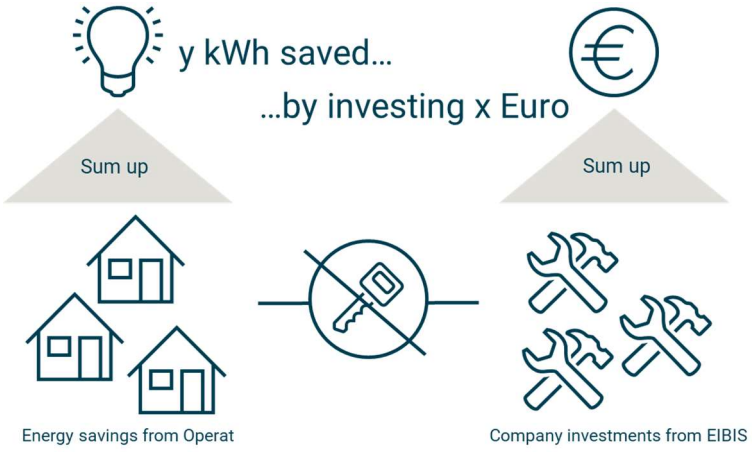


Figure 41: Data matching by aggregation

A common method used to circumvent the lack of a primary key, is to perform a data aggregation using (hopefully) comparable groups in both data collections, and **comparing the total energy savings with the total amount invested**. However, this way of comparing/joining different datasets, which are not specifically designed for comparability, is **highly error-prone**:

i) It is non-trivial to perform the selection of comparable groups, because **most datasets do not have the same segmentation criteria like industry codes, codes for location**, etc. Without comparable groups, putting the energy data in relation to Euro invested leads to arbitrary results.

ii) **Many datasets are inherently and differently biased** depending on how they are collected. For example, voluntary response samples over-sample those with strong interest and under-sample those with lower interest. There is typically no way to detect and remove such biases before performing a data aggregation.

iii) Sometimes when more than two datasets are available, a procedure called **triangulation can be used to scale aggregated results in such a way that consistent numbers are created**, based on the ratio of the resulting numbers in the various possible comparisons.

Such techniques are frequently used when different sources of data need to be combined. However, **the missing primary key to link energy efficiency to investments and as well as the heterogeneous scope of the various existing data collections makes it particularly difficult to aggregate data for achieving the desired scope**.

4.1.3 What can be done?

Establishing primary keys for data matching is the principal and crucial step in enabling the usage of existing datasets in new ways without performing a completely new data collection. For the task of collecting and monitoring data on energy efficiency investments, investor's data need to be linked to energy efficiency improvements/upgrade of objects via identified transactions (see Figure 42).

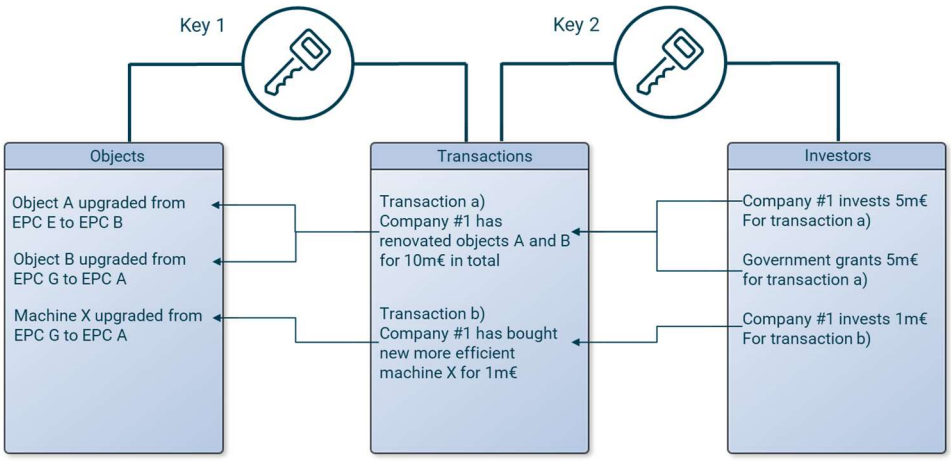


Figure 42: Data model for monitoring energy efficiency investments

To achieve that linkage, a two-step model is likely to prove useful: **investors invest in transactions, which ultimately are spent on objects, e.g. buildings, machinery, etc., in order to improve their energy efficiency**. In

a technical sense, **transactions are used to map invested amounts to the objects, where they are spent**. Such a data model would provide traceability of the investments and would hold for various scenarios of investing energy efficiency.

Of course, the three parts of such a data model could be collected separately, by different organizations or projects, however, utmost care needs to be taken that the keys still match and that a setup is provided, which allows for connecting the data points in a safe and potentially confidential manner.

4.2 Example on how to move forward: EuroDat and its SME questionnaire

EuroDaT [59](short for *European Data Trustee*) is a publicly funded research project with the aim to create the necessary legal, organisational, and technical framework for the first neutral data intermediary following the EU's Data Governance Act.

EuroDaT strives to strike a fair balance between *data sovereignty* (i.e. keeping full control over my data) and *ease of sharing*, by being able to perform the necessary legal and technical setup in a standardised fashion before an actual data transaction takes place, thereby reducing the initial hurdle while allowing swift transfers once the onboarding[60] has been completed.

By using the technical framework provided by GAIA-X description of available data, contracts and even contract negotiations can be standardised and automated while being interoperable with other data spaces.

EuroDaT however aims to facilitate data sharing by reducing the need to actually exchange raw data: in a scenario, where a data consumer would be satisfied with the result of a trustworthy analysis, instead of performing the analysis on the raw data himself, EuroDaT offers the possibility to run analysis algorithms in isolated containers neither accessible by the data owner (thereby preserving the confidentiality of the analysis algorithm), the provider of the analysis algorithm, the data consumer nor EuroDaT itself.

Given the complexity of the legal groundwork (which not only has to take into account the individual sets of data itself but also the criticality of joint sets, which might for example have implications with antitrust law), within the research project, EuroDaT focusses on four use cases including ESG. The efforts there are two-fold:

- On the one hand, EuroDaT will serve as the data trustee for an ESG ecosystem[61], where data providers will achieve a fair share of services built on top of the data provided.

59 https://www.eurodat.org

60 Onboarding here refers to signing up to the legal framework of Eurodat and establishing the IT interface to the platform.

61 https://www.dataland.com

This includes an SME questionnaire collecting the most important ESG key figures.

- On the other hand, a distributed algorithm to gather a market opinion for non-listed companies while preserving the confidentiality about the modelling and the opinion itself.

Hence, EuroDaT strives to facilitate both availability of (machine-readable) data by lowering the entry barrier and preserving data sovereignty as well as to fill gaps where no data is available by providing means to aggregate confidential opinions.

One of the first ESG use cases, which will be implemented in this framework, is the before mentioned ESG questionnaire for SMEs. With the European Banking Authority (EBA) Guideline on loan origination and monitoring[62] entering into force, institutions are required to consider ESG factors in their credit policies and procedures. So far, relevant ESG data from SMEs is often not available and therefore needs to be collected from third party data providers or from the SMEs directly or estimated using already available data of the SME.

To simplify and standardize the process of ESG data collection from SMEs, a SME questionnaire is being developed in cooperation with different institutions and bank associations in Germany. SMEs will be able to fill in the questionnaire in an online web interface and then securely share their data with different institutions using the ESG ecosystem. Authorized institutions can then use this data in their loan origination process to estimate relevant ESG KPIs like Greenhouse Gas Emissions or physical risks, without collecting the data by themselves. Additional applications in the ESG ecosystem, which will be developed in the future, will provide approximation models to estimate relevant ESG KPIs using the provided data.

SMEs as well as institutions benefit from this solution:

- Data only needs to be entered and updated once by SMEs.
- "One click" release of required information by SME for expedited application process.
- Sovereignty over the release of data remains with the SME, EuroDaT guarantees compliance.
- Favourable cost structure due to avoidance of intermediaries.
- Fees are incurred only for the use of the architecture, not for the data.
- The credit institution can apply its own models to the raw data or use the approximation models provided by additional apps.

62 https://www.eba.europa.eu/

The questionnaire contains information on production, consumption and location data of the SME, among others, i.e. information, which the SME is able to provide easily and quickly. Since energy efficiency is a relevant information to estimate transition risks, the questionnaire asks for the share of investments that was primarily spent on energy efficiency improvement measures in the last fiscal year.

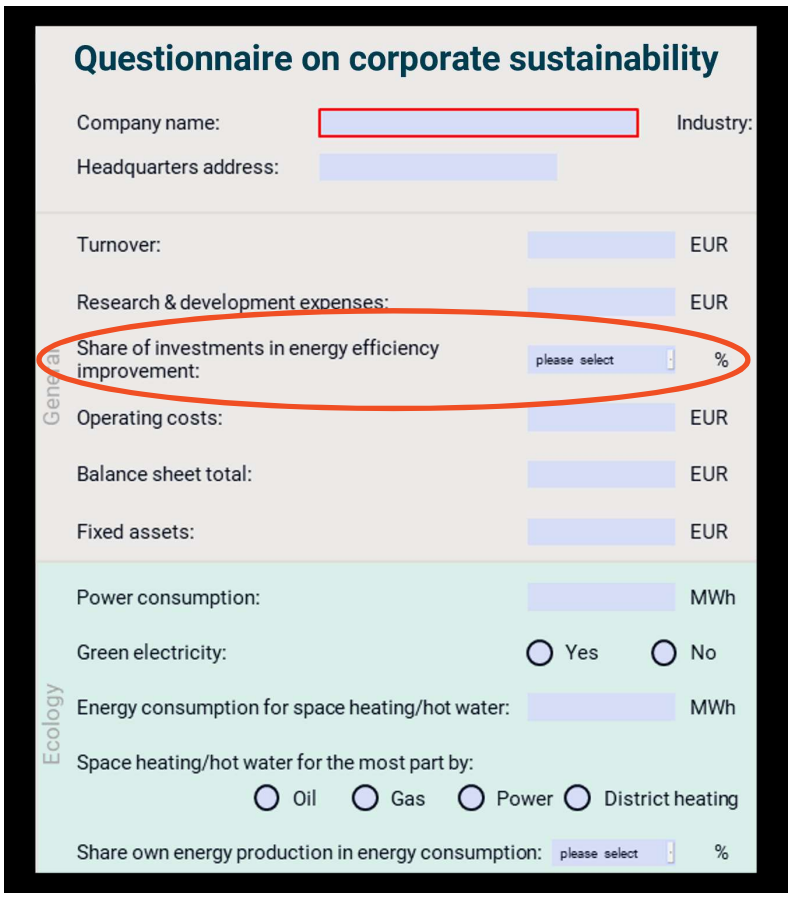


Figure 43: Draft of the SME questionnaire including a question on the investments in energy efficiency measures

Additional use cases in this framework could comprise the confidential sharing of energy consumption data or more granular energy efficiency investment data between companies for creating suitable statistics and benchmarking.

Overall, the EuroDaT ecosystem will provide a **versatile tool to enable safe and secure data sharing** wherever needed, including creating the links between the datasets as mentioned in the previous paragraph.

Similar initiatives can be found in the market, e.g. at Icebreaker 1, which also intends to provide such an ecosystem for safe and trusted data exchange.[63]

[63] See document https://docs.google.com/presentation/d/1azYF9q6LEYf2edjEVQWLeCJO0C8dsTI2RE0cPLFs6pU/edit#slide=id.gcfdc885ebe_1_0

5 Conclusions and recommendations

The research, analysis and stakeholder engagement conducted by the Working Group have shed light on some of the core issues and challenges related to the tracking of energy efficiency investments in the EU. By assessing the variety of existing data collections and methodologies, it became clear that tracking energy efficiency investments is multifaceted topic where precision, in terms of defining the objectives and approaches, is critical as there is no one-size-fits-all solution in this field.

Energy efficiency investment data is inherently more complex than counting renewable energy installations or green steel production volume, as energy savings are delivered both purposefully and indirectly through many types of capital investments, and as a part of regular operations or upgrades paid for in cash. Further, energy efficiency investment performance depends upon an imagined "base line" (that provides a reference in a parallel world where the investment had not been made) and often the savings are estimated or simply deemed by design. Fully scaled and investment performance data are also situationally dependent and therefore hard to extrapolate.

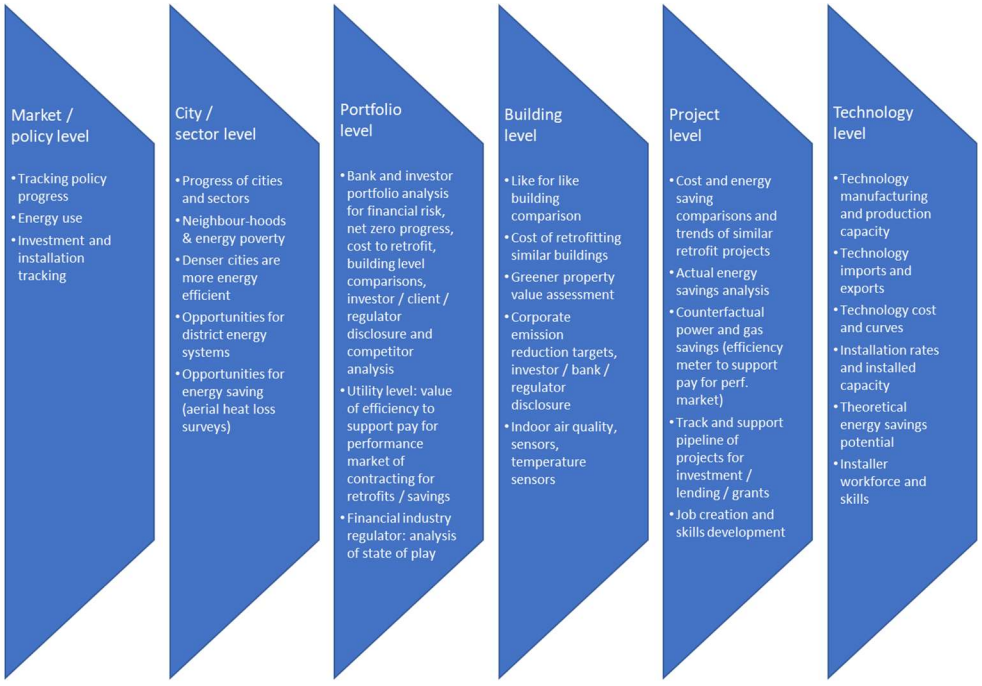


Figure 44 Tracking energy efficiency investments is a multifaceted topic

Given this intrinsic complexity, the issues and challenges can be grouped in three major areas, as follows.

1. **There is no single dataset identified which would by itself support the EC's effort to track and monitor energy efficiency investments across sectors and member states**. The empirical data that can be used to establish a baseline of investments and that can be tracked over time, of course, is a critical pillar for any effort to track investments. In the field of energy efficiency, there are a good deal of

scattered partial datasets but clearly a lack of data collected at a consistent quality across multiple end use sectors and geographical areas. Nonetheless, there are principles and approaches that can guide the EC's next steps. Overall, the Working Group does not assess the current state as sufficient. 73% of the group survey respondents stated that the data needs of the European Commission in terms of energy efficiency investments cannot be met by existing datasets and 60% recommended the European Commission start its own data aggregation or collection.

2. **None of the methodologies assessed by the Working Group fulfil all the requirements of the European Commission.** Due in considerable part to data related challenges, it is not possible at this time to detail an "off-the-shelf" methodology and/or analytical model that the EC could deploy to track energy efficiency investments. The right methodology for the EC, including the selection of specific datasets, analytical frameworks, estimations, assumptions, and other core aspects, needs to be established as part of an **ongoing and iterative** effort, ideally as a follow-up to this Working Group and – most importantly – involving Eurostat representatives as active part of the methodology development. More specifically the rationale for the data collection should be imbedded at the start and be directly connected to the policies of which it is born and towards which it must contribute.

3. **Various organizations have presented their governance models, and while there is no 1:1 fit to the needs of the European Commission, there are aspects of several governance models which can be combined within Eurostat for improved policy making.** Closely tied to the development of a methodology is the question of governance. Which resources could lead on developing and improving a methodology while driving programmatic data collection, analysis and other important activities? How to ensure effective oversight, quality assurances and other standard governance aspects? It is clear that IEA and EIB have both over a decade's worth of experience in this field and can support Eurostat's governance model with Member States.

The following sections summarise the Working Group's main conclusions and recommendations according to the three areas listed above, whereby there are some time-bound considerations that cut across all three areas. More specifically, the EC is advised to develop a view on how the tracking of energy efficiency investments in the EU will be conducted in a short, medium and long-term scenario.

In the **short-term**, for example, the EIBIS survey could be continued and extended. It offers a credible data collection effort that can be scaled without the need to establish new governance structures or other building blocks. In parallel and for the **medium-term**, a more defined data structure and methodology could be created from the intelligence and insights summarised in this report with regards to the BCBS framework and existing initiatives using Horizon

Europe funding, and potentially extending other existing best practices. It is worth adding that although this is a mid-term effort, it would nonetheless begin to imply at least some resource commitment with initial coordination from within the EC's Directorates or support services / agencies.

In the **long-term**, robust and consistent data collection would need to be deployed to ensure that a solid evidence base is created. This can add value to investors, policy makers and a range of market actors looking to better understand, promote or otherwise engage with energy efficiency investments. Joint governance structures are advised to ensure that the data created is "fit for purpose" as the investment required to generate high quality data needs to directly pay-off through improved policymaking and to deliver increased private sector appetite to invest. Strong governance is absolutely critical to support such a longer-term effort, with associated resource and cost implications to be determined, whereby an external or EC associated organisation would likely be tasked to lead this effort (over multi-year tranches with periodic EC review, for example).

5.1 The short-term scenario: extend existing surveys

This report shows there is a diverse number of approaches to the creation of data and that the identified and examined data collection methods fulfil just their specific task. This Working Group has a scope which covers the collection and monitoring of energy efficiency investment data for both residential buildings and companies, covering both larger corporations and SME businesses.

In the short-term, and using what we have identified, how can we be sure that the data, with suitable extrapolation, actually covers the entire required scope?

In section 4.1, we propose combining and bringing different data sources to the same level of granularity and linking them by suitable primary keys. This is a complex and error-prone task when datasets were not already designed for that from the very beginning. We could extend data collection for buildings to also cover companies, but buildings are physical objects which makes them accessible to satellite and AI-based methods, but these data models are not often suitable for the wide range of SMEs and companies operating in different industrial sectors.

The ways companies consume and use energy, and in particular improve energy efficiency, goes beyond the relatively well-defined (and limited) set of energy efficiency improvement measures available for buildings like insulation, HVAC, heating methods, etc. Which in turn also means that the energy efficiency improvement measures of companies in general cannot be traced by tracking the sales of a fixed list of items like e.g. heat pumps or insulation materials.

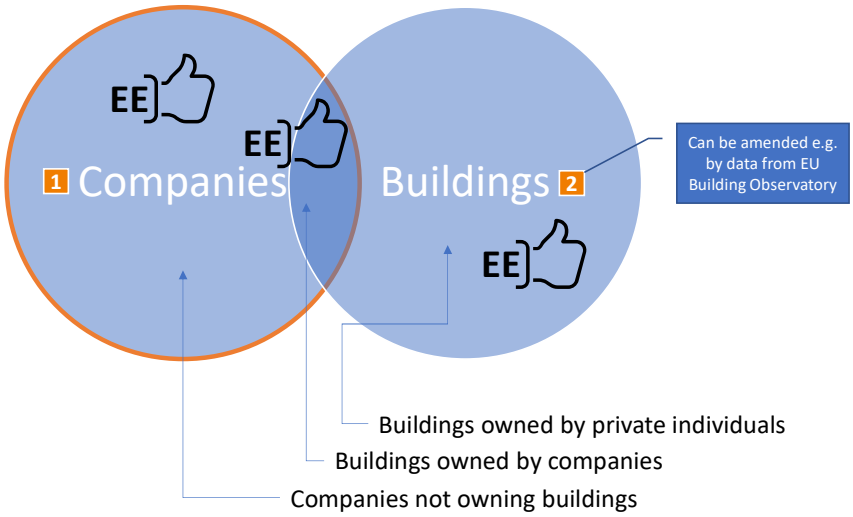


Figure 45 Scope of data collections needed to cover the European Commission's task given to this Working Group

The issue is that companies also own buildings and report energy efficiency investments in their buildings alongside and mixed with process energy efficiency investments. This means there are three blends of data source we need to cover to sum to all EU energy efficiency investments from:

a) Buildings which are not owned by companies, but by private individuals.

b) Buildings which are owned by companies, which can be residential as well as commercial buildings.

c) Companies which do not own real estate.

One could survey building owners to cover a) and b) or one could survey companies to cover b) and c). EIBIS, for example, covers a representative sample of companies, but not of buildings.

The Working Group believes that in advance of a formal Eurostat-led collaboration with Member States on identifying and collecting energy efficiency investment information more fully, there are ways to triangulate estimates of EU energy efficiency investments. This can be achieved through building on some of the existing organisations and approaches to offer a template for future development.

Firstly, a company-focused approach can offer a representative sample of companies which own buildings and cover process energy efficiency. Such an approach can be included as an extension of the EIBIS, and might ask:

1. How did your firm invest in energy efficiency last year reported in three categories: i) Process energy efficiency improvements; ii) energy efficiency investments into commercial or industrial buildings; and iii) energy efficiency investments into residential buildings?

2. (Question only if your company is in the business of selling and installing corresponding equipment for improving energy efficiency) -> Which proportion of the equipment was sold and installed in a commercial setting, and how much was sold for non-commercial customers?

The EIBIS approach may struggle to adequately cover buildings beyond the company scope, even though one could address specific survey questions to a number of retailers of typical products, which cater to the renovation trade. The results could then be extrapolated to provide the corresponding sales numbers to private customers overall. This is one option to cover the privately owned residential buildings, which are not directly surveyed by EIBIS.

Surveys addressed to companies are easier to conduct typically compared to survey of buildings owners, with the only exception being when AI-based methods are used to actually gather data on buildings without contacting buildings owners etc. By using this indirect approach, the data collection can provide a template for a more formal approach with the collaboration of Member States.

Secondly, sales data on energy efficiency equipment, like heat pumps and insulation, is hard to track (in terms of the type of customers where it is installed), yet companies involved in installing energy efficiency improving equipment can be surveyed. A specific survey could be established for the subset of companies which form a part of the supply chain to renovations of all kinds. Given that many renovations are budgeted and there are standard "rules of thumb" (and 3D architectural models) which can estimate the labour components to the renovation this can be considered as another way to triangulate to an energy efficiency investment figure for each Member State.

Thirdly, since 2016 the EU BSO has been collecting data on the physical energy performance of the building sector through reliable, consistent and comparable data. With already five years of historical data and 250 indicators, the BSO seems like a good place to include the investment data elements which MS should be collecting on buildings renovation investments which are linked to different building elements. The new provisions in the EPBD recast, which ask for regular data sharing from national data collection to the BSO, will further strengthen the role of the BSO in this context, which therefore can be a third component of the triangulation which will reveal the energy efficiency investment figures at the EU level.

Finally, financial institutions are increasingly dedicating efforts to collect data from their corporate and SME customers in order to fulfil non-financial reporting requirements and their compliance with the EU taxonomy and their overall alignment with climate and other ESG goals. If banks and other financial institutions are already starting to collect that information, the non-financial reporting from financial institutions could be collected on a pan-European data platform in a machine-readable format such that the information becomes more easily digestible and ready for analysis. Over time, those financial institutions collecting energy performance information of the assets and businesses they finance can help orient data architectures and approaches for policymakers.

Further, energy efficiency lending activities and those related to buildings renovation would have to be specifically tagged to become visible, as was noted by leading financial institutions in 2017[64].

> **The next step in the short-term scenario:** From a practical perspective, and considering consistency of the result as key objectives, a survey-based data collection is the most flexible and timely approach for the European Commission to follow up. Also, in terms of costs and benefits, survey of a representative sample of European companies with the questionnaire design outlined above is likely to provide the highest value in the short-term. The Working Group recommends to the European Commission to use such an approach as the next step in that evolving area of interest.

However, there is one drawback when using financial institutions as investment data aggregators: A significant number of home renovation investments are made outside the context of business relationships with financial institutions, which would not be covered by any data collection via financial institutions. So, to fully cover the scope of data collection envisaged by the European Commission, a data collection directed to all companies in Europe (or at least a representative sample thereof) is required.

5.2 The medium-term scenario: developing a fit-for-purpose methodology

The WG identified two approaches to developing a fit-for purpose methodology. The first approach can be described as 'static', meaning it is based on the existing datasets identified, work and analysis conducted by the WG during the project term, whereby the output is a set of "best practice" recommendations for how best to analyse and track energy efficiency investments for a defined purpose.

The 'dynamic' approach, in contrast, includes a set of recommendations for how the EC can track energy efficiency investments over the longer term and carries important implications in terms of resourcing (staffing) and governance, among others. It essentially charges the EC with long-term **ownership** over tracking energy efficiency investments as one function of its administrative services (and potentially with the support of vendors and other partners).

The WG believes **that the EC could adopt the dynamic approach** in order to ensure accuracy and value added compared to existing efforts, such as those conducted by the IEA, from within Horizon Europe and EIB. Rather than a static piece of analysis based on a moment in time and a clearly defined set of data,

64 Green Tagging: Mobilising Bank Finance for Energy Efficiency in Real Estate, UNEPFI found: https://wedocs.unep.org/bitstream/handle/20.500.11822/26627/Green_Tagging.pdf?sequence=1

the dynamic approach is an **ongoing effort that the EC itself would need to more clearly define and subsequently establish**.

The implication of this recommendation is that some core activities can already be identified based on the conclusions of this report. These include:

- The establishment of a standing expert group or other advisory body to define a fit-for-purpose data architecture and strong data governance.
- The development of a statistical concept paper that outlines the relevant definitions and data objects to be collected.
- The design and development of suitable data collection templates and data structures for storing and accessing the collected data (building upon the approaches already deployed by Eurostat and the Cordis environment).

In addition, and as reflected in the executive summary, the EC can frame both any immediate as well as mid or long-term efforts around some of the **core learnings** that emerged from this EEFIG Working Group, including:

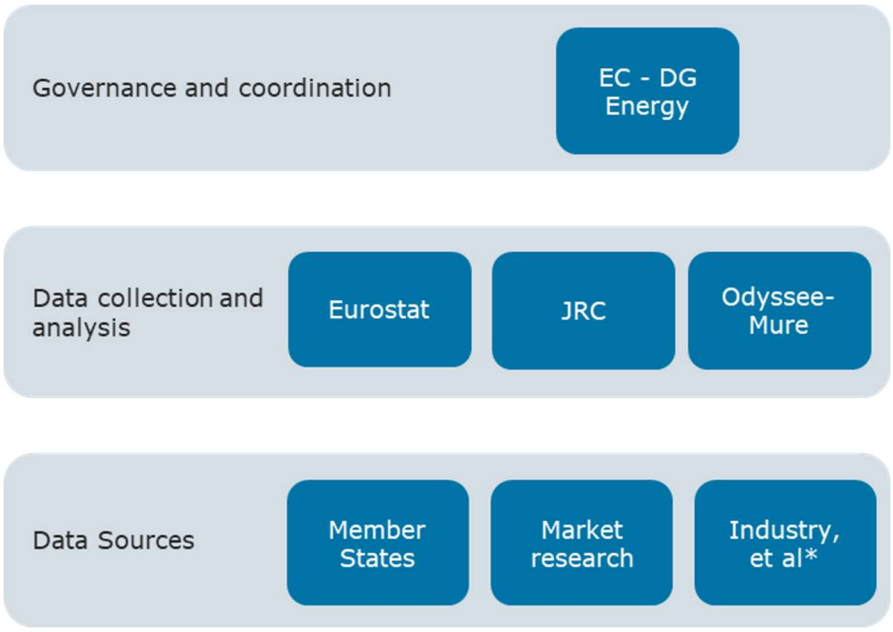
- Energy efficiency investment data is always likely to be **disparate and inconsistent**, particularly across different countries and sectors, even if data quality is much improved.
- A **sectoral approach** is required to consider energy efficiency investments since fundamentals of investments (including origination of funds) will differ strongly between residential and industrial settings, for example.
- **Existing/long-standing efforts** by national energy agencies, the IEA, the EIB and various Horizon 2020 projects can be built on and/or expanded as appropriate. An expert working group of data specialists in the area could be launched.
- Advances in **AI and machine learning** offer significant potential for automation, increases in scale and speed, reduction of human error and other potential advantages for the EC to consider and explore. These methods can fill in in the case of data gaps, but additionally they scale very well once established. For example, developing a database containing the full building stock Europe can be achieved much faster, when the shape of buildings is automatically extracted from satellite images using image recognition technologies.
- Combined with ongoing data collection supported by strong governance, the EC should consider a **hybrid approach** that combines existing structures (e.g., Eurostat, Member State official databases, etc.) with AI, bottom-up and top-down estimates, proxies, extrapolation, case studies, etc.

It is likely that initial attempts to formalise a fixed methodology will be complex and potentially "messy" given not only the disparate nature of data, but also given the very nature of energy efficiency interventions in buildings, industries, homes, etc. **Clear definitions and boundaries** – meaning what constitutes an energy efficiency investment and what is included/not included in such investments – will be fundamental to ensure avoidance of double-counting and to create market-worthy credibility for official EC investment numbers.

In light of the challenges related to data sources, the WG recommends that the EC deploys **dedicated and consistent** resources to the collection and analysis of energy efficiency investment data. Our assessment is that the EC needs to push actively on data collection and on connecting the dots between empirical and estimated data, while leading on the development and iteration of a bespoke methodology for the EU.

Assuming that it may not be possible for the EC to dedicate staff within one of its departments to this effort, supporting organisations, such as the JRC, could be tasked to drive the ongoing development of the methodology and related efforts, such as the convening of a standing expert group, programmatic data collection, analysis, etc. The example diagram in Figure 46 is intended to serve as a loose illustration of what such a governance structure could look like.

As part of a standing expert group, international bodies such as the IEA could feed into this effort on a semi-regular basis in an advisory capacity, comparing information and sharing best practice. The EC, meanwhile, could ensure that this work and its outputs are framed by a sound data governance structure with clear stakeholder review and sign off.



**Data sources will be extensive – please refer to chapter 3 for more details.*

Figure 46 Example of EC governance structure for data collection & analysis

Tracking energy efficiency investments needs to be aligned to other carbon/energy reporting activities related to 2030/2050 goals, taxonomy, etc. This is not only for methodological coherence but also to ensure that this workstream is not siloed but rather can be in integrated within wider headline efforts on climate and energy.

Overall, the Working Group concludes that further significant steps are required to define a truly European data standard for measuring investments across the EU Member States and relevant industry sectors.

The next step towards the medium-term scenario: For starting the process of developing a data collection methodology, which fits the needs of the European Commission for policy making, defining the organizational setup is critical:

- Which unit is going to be responsible for the new data collection?
- In which organization should this unit be anchored?
- Who are the most important stakeholders?

This setup needs to be agile enough to take into account recent developments, for example the distortions in the energy market due to the Russian war against Ukraine, as well as changing needs on the side of the European Commission.

5.3 The long-term scenario: integration into Eurostat

Once the data requirements and the methodology have been sufficiently tested and can be regarded as stable, the medium-term solution as described in the previous section needs to be transferred into a long-term solution to support the monitoring over the full decarbonisation path until 2050. The standard long-term solution for EU-wide data collections is their integration into Eurostat's processes and data structures.

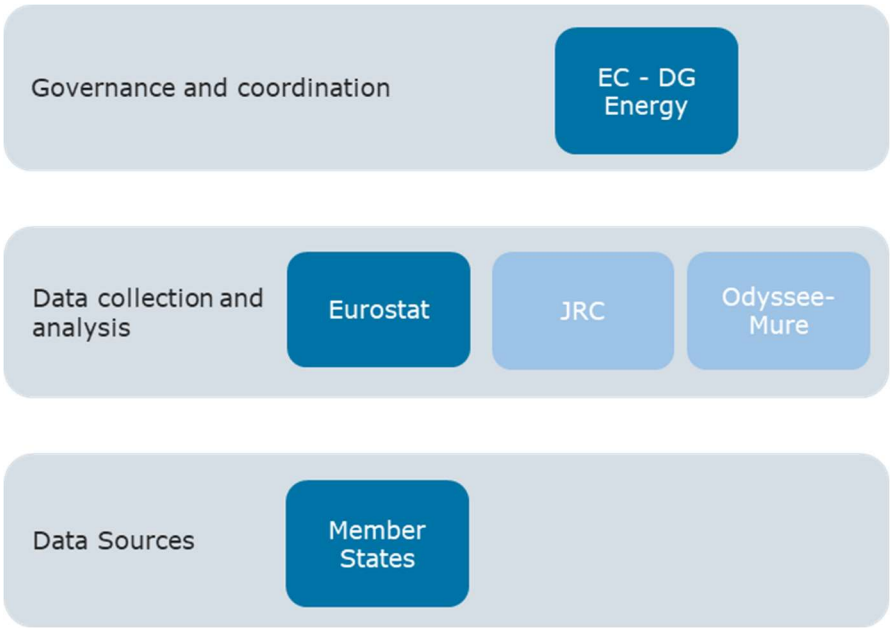


Figure 47 Integration of EU-wide data collections into Eurostat

The Working Group recommends to use the medium-term solution to resolve methodological issues and make sure that a high degree of maturity is reached before the work on the long-term solution is started. But using the well-established processes and interface at Eurostat provides a level of governance which is hard to reach with other solutions, although the power of AI will only increase in the coming years. Also, in terms of accessibility and security, Eurostat is the gold standard for providing a robust tool for policy making and policy monitoring.

The Working Group also assumes that a reliable and consistent data collection across all Member States will be of high value not only for the European Commission, but also for organization like the IEA as well as for NGOs, which at the moment in their analysis need to rely on inconsistent and unreliable data sources.

The next step towards the long-term scenario: The dialogue with Eurostat needs to be established rather soon such that the requirements from the medium-term stage can be aligned with Eurostat's requirements and internal processes. Once the methodology and data requirements have been finalized in medium-term stage, a legislative process needs to be initiated with the objective to finally make the new data requirements not only consistent but also enforceable across Members States.

6 Appendices

Appendix A Summary of the IEA methodology

Summary of IEA methodology to track global investments in energy efficiency

Problem statement

Identifying and monitoring global levels of investment in energy efficiency across the buildings, transport and industry sectors in a manner that is comparable with investments in energy supply (fossil, nuclear, renewable).

Definitions

An energy efficiency investment is "the incremental spending to acquire equipment that consumes less energy than would otherwise have been used to provide the service, such as lighting, heating or mobility, had the consumer not bought a more efficient option (i.e. the baseline)."[65] IEA considers three 'layers' of EE investments:

- pure: energy efficiency services markets (ESCOs being the prime example)
- quasi-pure: energy efficiency goods and services (LED lighting, insulation, energy management systems, NZEB)
- incremental (new and replaced capital stock): design and construction of buildings "above code"; appliances, motors, etc. for goods manufacturers

Sectoral approaches

Buildings

- change in cost for services (design, delivery, installation) and products (lighting, appliances, equipment and materials) that achieve increased energy efficiency performance beyond investment required for minimum legal performance (codes, standards)
- where no legal standards in force, change in cost = incremental spending on energy efficiency services and products beyond what would have otherwise been spent (in some cases there is no spending)
- full cost of a building renovation = investment in energy efficiency as long as renovation features energy efficiency improvements
- if recent change in standards/codes, change in cost = incremental spending needed to achieve the new energy performance requirements beyond previous level to which market had already adapted
- energy efficiency obligations, loans and funds established by policy are considered as incremental spending
- if sufficient datasets not available, IEA defines proxies and relevant quantities related to energy efficiency investments in buildings to estimate missing data, relying on general indicators as well as outputs of the Energy Technologies Perspectives (ETP) model, which provides percentage figures for incremental investments across key building efficiency technology areas, notably space and water heating, cooling, lighting and envelope[66]

Industry & freight transport

65 https://iea.blob.core.windows.net/assets/05533a49-fa6b-4cf9-8362-180dad9493b1/WEI2019-Methodology-Annex.pdf

66 For building LED lighting upgrades or LED lighting related expenses in construction, for example, 85% of investments are considered efficiency related for this particular technology.

- incremental investment calculated based on average technology efficiency in a recent base year, where result is modelled on a regional basis and based on the realised level of energy savings in a sector and energy saving cost curves in the World Energy Model[67]
- data on investments in energy management systems (e.g. ISO 50001)

Transport: light duty vehicles

- additional price of each efficient vehicle sold (defined as those in the top 25% for fuel economy in their size and power class, according to the Worldwide Harmonised Light Vehicles Test Procedure [WLTP]) compared to the average price of vehicles in eight size and eight power classes in each country in that year
- different size and power classes considered to take into account expressed consumer preferences and to maintain principle of reduced energy demand for the same level of energy service provided

Transport: electric light duty vehicles – battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV)

- electricity consumption converted to litres of gasoline equivalent on a WLTP basis
- underlying data derived from IHS Markit (2018) and supplemented with public data sources and Marklines (2020), according to the general methodology of the Global Fuel Economy Initiative (GFEI, 2019)

Information sources

Buildings	• published national reports (government departments, agencies and public institutions) • industry sources, construction-sector indices and studies of capital cost requirements • building energy use data from the IEA's ETP which also provide data on both residential and non-residential building stocks (floor area, number and age of buildings, etc.) and which are linked closely to the IEA's statistical database • academic studies, Industry benchmarking reports • information provided by financial institutions, most notably the KfW in the case of Germany • data from consumer appliances markets (e.g., energy efficiency equipment and technology sales data)
Industry	• World Energy Outlook energy savings data and cost curves for energy savings • published data on investment in industrial energy management systems
Transport	• IHS Markit (2018), supplemented with public data sources, according to the general methodology of the Global Fuel Economy Initiative (GFEI, 2019) as well as Marklines (2019)

In addition, interviews with sector experts are used to validate and complement the analysis.

Sector and subsector baselines

Sector	Subsector	Baseline
Buildings	Building envelope, HVAC (heating, ventilation, and air conditioning) and controls	Minimum energy performance standards for new construction, incorporated into the baseline with a time lag of several years to reflect adoption of the standard into the value chain.

67 https://www.iea.org/reports/world-energy-model

		For retrofits of existing buildings, all spending is incremental.
	Appliances and lighting	Minimum energy performance standards, incorporated into the baseline with a time lag of several years
Industry	Energy-intensive industry	Sector average technology efficiency in prior year and no energy management system spending
	Other industry	Sector average technology efficiency in prior year and no energy management system spending
Transport	Light-duty vehicles	Average efficiency of new vehicle sales, per size and power class
	Freight vehicles and other transport	Average intensity of different modes in the prior year

Issues and challenges

- Comparability: can energy efficiency investments really be comparable to energy supply side investments, e.g. different paradigms and complex energy efficiency definitions?
- Additionality and 'green premiums: how to determine amount of investment that is really incremental or additional, and what about cases where more efficient options costs the same or even less than alternative – no more 'green premium'?
- Data availability and consistency: datasets aligned to above are not consistently available across geographies

    Limited geographical coverage: For Europe, data is collected from only 5 countries: Germany, France, Norway, Switzerland, and the UK (whereby Turkey is also included in the scope of the analysis)

Appendix B The Working Group's library

Document	Link
CPI's Global Landscape of Climate Finance 2019	Global Landscape of Climate Finance 2019 - CPI (climatepolicyinitiative.org)
European Climate Initiative (EUKI)'s How to Assess Investment Needs and Gaps in Relation to National Climate and Energy Policy Targets: a Manual - and a Case Study for Germany	Juergens-et-al.-2019_Germany-_INGA-Full-report.pdf (squarespace.com)
IKEM's Climate and energy investment map – Czechia	Climate and energy investment map – Czechia – IKEM
IKEM's Investments in Energy Efficiency and Renewable Energy Projects in Latvia in 2018	Investments in Energy Efficiency and Renewable Energy Projects in Latvia in 2018 – IKEM
IEA's Energy Efficiency Questionnaire	Questionnaires – Data and statistics - IEA
CPI's Global Landscape of Climate Finance 2019 - Methodology	GLCF-2019-Methodology-Document.pdf (climatepolicyinitiative.org)
IEA's Energy Efficiency 2021	Energy Efficiency 2021 – Analysis - IEA
IEA's Methodology Annex to World Energy Investment 2020	WEI2020MethodologyAnnex.pdf (windows.net)
IEA's Energy Efficiency Indicators: Fundamentals on Statistics	Energy Efficiency Indicators: Fundamentals on Statistics – Analysis - IEA
IKEM's Climate and energy investment map in Germany 2016	Climate and energy investment map in Germany – Status report 2016 – IKEM

Document	Link
IKEM's Überblick zu den Investitionsströmen der Energiewende in Deutschland und Frankreich: Vergleich von Methoden und ausgewählte Ergebnisse (in German)	Überblick zu den Investitionsströmen der Energiewende in Deutschland und Frankreich: Vergleich von Methoden und ausgewählte Ergebnisse – IKEM
I4CE's and IKEM's Tracking investment into energy transition in Germany and France: a comparison of methodologies and selected results 2019	Tracking investment into energy transition in Germany and France: a comparison of methodologies and selected results - I4CE
JRC's Financing energy renovations at local and regional levels	JRC Publications Repository - Financing energy renovations at local and regional levels (europa.eu)
CPI's The Landscape of Climate Finance in Germany	German Landscape of Climate Finance (climatepolicyinitiative.org)
OECD: Estimating publicly-mobilised private finance for climate action - A South African case study	Estimating Publicly-Mobilised Private Finance for Climate Action : A South African Case Study | OECD Environment Working Papers | OECD iLibrary (oecd-ilibrary.org)
OECD: Measuring the alignment of real economy investments with climate mitigation objectives	Measuring the alignment of real economy investments with climate mitigation objectives : The United Kingdom's buildings sector | OECD Environment Working Papers | OECD iLibrary (oecd-ilibrary.org)
I4CE's Panorama des financements climat (in French)	Panorama des financements climat en France - I4CE
WiseEuropa, NewClimate Institute and I4CE's Renovation. Landscape of climate finance in the Polish buildings sector	Renovation - Landscape of climate finance in the Polish buildings sector - EUKI

Document	Link
CPI's The Landscape of Climate Finance in Germany: Annexes	The-Landscape-of-Climate-Finance-in-Germany-Annexes.pdf (climatepolicyinitiative.org)
CPI's Updated view on the Global Landscape of Climate Finance 2019	Updated View on the Global Landscape of Climate Finance 2019 - CPI (climatepolicyinitiative.org)
IEA's World Energy Investment 2019	World Energy Investment 2019 – Analysis - IEA
Italy: Energy Efficiency Report 2018 - Energy Efficiency Report (in Italian)	Il mercato dell'efficienza energetica in Italia dalla prospettiva degli utenti finali | QualEnergia.it
Ademe's Marchés et emplois concourant à la transition énergétique dans le secteurdu bâtiment (in French)	Marchés et emplois concourant à la transition énergétique dans le secteur du bâtiment résidentiel - La librairie ADEME
DiW's report on German construction activity, 2021	DIW Berlin: German Construction Industry Remains on Its Path of Growth during the Coronavirus Recession
KfW's Förderzahlen, 2020 (in German)	KfW Förderzahlen 2020
KfW's Förderreport; municipalities renovation (in German)	Microsoft Word - Dokument1 (kfw.de)
IEA Sustainable Recovery Tracker Policy Database	Explore policies – Sustainable Recovery Tracker – Analysis - IEA
EIB Investment Survey (EIBIS)	EIB Investment Survey (EIBIS)
Emmy: Residential white certificates (CEE) (in French)	Emmy - Données mensuelles
ANAH - Habiter mieux et al. (thermal refurbishments of homes of low-income households) (in French)	Actualité-presse - Chiffres clés 2020 : des résultats exceptionnels (anah.fr)
Projet de loi de finances de finances pour 2019 : Écologie,	Projet de loi de finances de finances pour 2019 : Écologie,

Document	Link
développement et mobilité durables : Énergie; Residential tax credit 2019 (in French)	développement et mobilité durables : Énergie (senat.fr)
2021 EIB Investment Survey: *see p. 31&32*	EIB Investment Bank Investment Survey 2021
IEA's Residential heat economics calculator	Residential heat economics calculator – Analysis - IEA
European Court of Auditors special report: Energy efficiency in enterprises	Special Report 02/2022: Energy efficiency in enterprises - Some energy savings but weaknesses in planning and project selection (europa.eu)
CPI's Tracking Incremental Energy Efficiency Investments in Certified Green Buildings	Tracking Incremental Energy Efficiency Investments in Certified Green Buildings - CPI (climatepolicyinitiative.org)
BoE's Climate policy and transition risk in the housing market	Climate policy and transition risk in the housing market | Bank of England
UK's BEIS: Improving home energy performance through lenders	Improving home energy performance through lenders - GOV.UK (www.gov.uk)
BoE's Does energy efficiency predict mortgage performance?	Does energy efficiency predict mortgage performance? | Bank of England
UK's BEIS Evaluation of the Domestic Private Rented Sector Minimum Energy Efficiency Standard Regulations	Domestic private rental sector minimum energy efficiency standards: interim evaluation 2020 - GOV.UK (www.gov.uk)
BTA Climate-KIC Building Market Brief insights for SUI, FR, UK, NED, DE	Building Market Briefs - Climate-KIC
RAP's Measuring and increasing impact: The next challenge for EU energy efficiency policy measures	Measuring and increasing impact: The next challenge for EU energy efficiency policy measures (raponline.org)

Document	Link
JRC's Monitoring R&I in Low-Carbon Energy Technologies Methodology for the R&I indicators in the State of the Energy Union Report, 2016 edition	Monitoring R&I in low-carbon energy technologies - Publications Office of the EU (europa.eu)
JRC's SETIS R&I country dashboards contain time series of research and innovation investments and trends in patents in the Energy Union R&I priorities and the SET Plan Actions for the EU MS	Joint Research Centre Data Catalogue - SETIS Research & Innovation country dashboards - European Commission (europa.eu)
OpenCoesione (DB): an integrated database on use of cohesion funds channeled to Italy	OpenCoesione - Home
EIB Investment Survey Germany 2021	EIB Investment Survey 2021 - Germany overview
ECF's dashboard on progress of Europe's buildings towards climate neutrality	ECF buildings dashboard
DG REFORM Public sector energy efficiency investment programme supporting Ireland's EU 2030 climate and energy targets	Public sector energy efficiency investment programme supporting Ireland's EU 2030 climate and energy targets | Trinomics
EIB working paper Group Survey on Investment and Investment Finance; A technical note on data quality	EIB Working Paper 2020/08 - EIB Group Survey on Investment and Investment Finance
RenOnBill tool to better evaluate energy efficiency interventions	RenOnBill
RenOnBill's national roadmaps for replication of on-bill schemes (IT, DE, ES, LT)	RenOnBill | National roadmaps for the replication of on-bill schemes

Document	Link
BPIE's briefing plan on RePowerEU energy savings plan	REPowerEU Energy Saving Plan: Time to switch to action > BPIE - Buildings Performance Institute Europe
H2020 RenOnBill project analysis on how EPBD in support of the uptake of on-bill schemes in the EU	EPBD in support of the uptake of on-bill schemes in the EU > BPIE - Buildings Performance Institute Europe
RenOnBill project's policy roadmap to maximize the uptake of on-bill schemes in the EU residential market	European on-bill building renovation roadmap > BPIE - Buildings Performance Institute Europe
ComAct's factsheet on EE and energy poverty reduction	ComAct (comact-project.eu)
X-tendo H2020 project reports test round for new features in EPC's; report for 9 countries	» Concrete implementation of new energy performance certificates features: testing and results in nine countries X-tendo Toolbox
UNEP FI's and CRREM/IIÖ's report on Managing Transition Risk in Real Estate	Managing Transition Risk in Real Estate: Aligning to the Paris Climate Accord – United Nations Environment – Finance Initiative (unepfi.org)
London Building Stock Model: database of all the energy and carbon data collected through the London Mayor's energy programmes and policies	London Building Stock Model | London City Hall
EIB's Going Green: Who is investing in energy efficiency, and why it matters?	Going green: Who is investing in energy efficiency, and why it matters (eib.org)

Appendix C The Working Group's structure and approach

Working Group Structure

The following two tables list the WG members and WG observers respectively:

Table 12 Members of the Working Group

First name	Last name	Institution	Role
Aleksandra	NOVIKOVA	IKEM	Member
Alessandro	FIORINI	ENEA	Member
Andriana	STAVRAKAKI	NTUA	Member
Atanas	KOLEV	EIB	Member
Christine	INSALACO	EIB	Member
Clemens	ROHDE	Fraunhofer ISI	Member
Dan	WINTERS	GRESB	Member
Debora	REVOLTELLA	EIB	Member
Didier	BOSSEBOEUF	Ademe	Member
Fotios	KALANTZIS	EIB	Member
Frank	HOVORKA	RICS	Member
Ian	HAMILTON	University College London (UCL)	Member
Kamila	PAQUEL	European Commission, CINEA	Member
Lorenzo	PEZATTI	EBRD	Member
Marina	ECONOMIDOU	Joint Research Center	Member
Nicholas	STANCIOFF	Funding for Future	Member
Paolo	BERTOLDI	European Commission, Joint Research Center (JRC)	Member
Paul	ROSANE	CPI Global	Member
Peter	HARASZTOSI	EIB	Member
Rajashree	PADMANABHI	CPI Global	Member
Rüdiger	LOHSE	DENEFF	Member
Simon	MINETT	Challoch Energy a member of COGEN Europe	Member
Susann	BOLLMANN	DENEFF	Member
Tanguy	DE BIENASSIS	IEA	Member
Vesna	BUKARICA	Energy Institute Hrvoje Požar	Member
Wolfgang	EICHHAMMER	Fraunhofer ISI	Member
Yannik	MONSCHAUER	IEA	Member
Zoya	VASSILEVA	Mattig- Management Partners	Member

Below is a table listing the observers of the Working Group.

Table 13: Observers of the Working Group

First name	Last name	Institution	Role
Agris	KAMENDERS	Riga Technical University	Observer
Alan	RYAN	Sustainable Energy Authority of Ireland	Observer
Alessio	SBARRA	FIRE - Italian Federation for the Rational Use of Energy	Observer
Aleksandar	HADZHIIVANOV	EBRD	Observer
Baysa	NARAN	CPI Global	Observer
Bettina	DORENDORF	KFW	Observer
Celine	TOUGERON	European Commission, CINEA	Observer
Christoph	HANSEN	RSU Rating Service Unit GmbH & Co. KG	Observer
Cynthia	WANG	EBRD	Observer
Daire	MCCOY	London School of Economics, Grantham Research Institute	Observer
Daniela	BACHNER	European Commission, CINEA	Observer
Evangelos	ALEPOCHORITIS	Honeywell Building Technologies	Observer
Fabio	NATALUCCI	IMF	Observer
Filippos	ANAGNOSTOPOULOS	IEECP - Institute for European Energy and Climate Policy	Observer
Fiona	RIDDOCH	Personal application. Linked organisations: Honeywell UK Pension Scheme, Coalition for Energy Savings	Observer
Francisco	GONÇALVES	Energy Cities	Observer
George	GURAN	Ministry of European Funds	Observer
Guillaume	JOLY	BEUC	Observer
Hadrien	HAINAUT	I4CE	Observer
Jasmin	CANTZLER	KFW	Observer
Jolien	NOELS	OECD	Observer
Katrin	WEISSENBERG	EBA	Observer
Lasma	ZAIKOVSKA	Funding for Future	Observer
Livio	DE CHICCHIS	FIRE - Italian Federation for the Rational Use of Energy	Observer
Luis	LOPEZ BRUNNER	European Industrial Insulation Foundation	Observer
Max	MAYWALD	GRESB	Observer
Michaela	VALENTOVA	Czech Technical University in Prague	Observer
Michela	AUFIERO	Local authorities	Observer
Murray	BIRT	DWS	Observer

First name	Last name	Institution	Role
Nick	KEEGAN	EEVS	Observer
Oleksandr	ANTONENKO	Energy Charter Secretariat	Observer
Raphael	JACHNIK	OECD	Observer
Rasmus	L'ANGLOIS-NORDGREN	Danish Energy Agency	Observer
Sebastien	DESCOURS	Énergies Demain	Observer
Simon	HASSE-KLEEBERGER	RSU Rating Service Unit GmbH & Co. KG	Observer
Simona	CALIN	Ministry of Finance	Observer
Tatiana	BOSTEELS	EIB	Observer
Theofano	FOTIOU	E3 Modelling	Observer
Valeria	CASO	FIRE- Italian Federation for the Rational use of Energy	Observer
York	OSTERMEYER	Chillservices	Observer

Table 14 Participation of Institutions to the Working Group

Observers	Members	Members
Ademe	BEUC	Honeywell Building Technologies
Challoch Energy a member of COGEN Europe	Chillservices	I4CE
CPI Global	CPI Global	IEECP - Institute for European Energy and Climate Policy
DENEFF	Czech Technical University in Prague	IMF
EBRD	Danish Energy Agency	KFW
EIB	DWS	Local authorities
ENEA	E3 Modelling	London School of Economics, Grantham Research Institute
Energy Institute Hrvoje Požar	EBA	Ministry of European Funds
European Commission, CINEA	EBRD	Ministry of Finance
European Commission, Joint Research Center (JRC)	EEVS	OECD
Fraunhofer ISI	EIB	Personal application. Linked organisations: Honeywell UK Pension Scheme, Coalition for Energy Savings
Funding for Future	Énergies Demain	Riga Technical University
GRESB	Energy Charter Secretariat	RSU Rating Service Unit GmbH & Co. KG

Observers	Members	Members
IEA	Energy Cities	Sustainable Energy Authority of Ireland
IKEM	European Commission, CINEA	
Joint Research Center	European Industrial Insulation Foundation	
Mattig- Management Partners	FIRE - Italian Federation for the Rational Use of Energy	
NTUA	FIRE- Italian Federation for the Rational use of Energy	
RICS	Funding for Future	
University College London (UCL)	GRESB	

Key Contributions and Results

This section provides a summary of the evidence collected by the WG during the two years of work in preparing the ground for this report. It is divided into subsections that correspond to each type of activity (i.e. expert framing interviews, key presentations and review of the identified datasets using WG survey):

Expert Framing Interviews

The consortium held interviews with nine experts from the Working Group to help frame the WG's approach and identify the key datasets. The following key sectoral findings emerged from these initial interviews:

- For **buildings**, energy efficiency investments can be broadly segmented into envelope, heating/cooling systems and appliances. Therefore, sales data of such items provides an estimate for the investment in energy efficiency. Measuring incremental housing investments is a way to provide a ceiling on energy efficiency and thereby avoid inflated estimates of actual investment amounts.

- For **industrial processes**, delivering substantial process energy savings typically requires a complete change of process or building a whole new factory. In these cases, total investments in the process or new building is a stronger indicator than measuring incremental investment.

- The IEA's World Energy Outlook (WEO) team began looking at energy efficiency investments in 2010 by examining how much spending had been disclosed by multilateral lenders, and then applying a leverage rate to project a total investment rate, applying an **incremental definition of EE investments for buildings and transportation**.

- The IEA also looks at the total cost of investing into all the hardware along two energy pathways, and then divides that by the efficiency improvement.

The interviews provided input to the following key questions:

  - What is the perimeter / scope of the EE calculation?
  - Who is responsible for the information?
  - Is it reliable?
  - What is the uncertainty factor?

- At the building level, the reliability of data is subject to significant uncertainty. Even the definition of the floor area (m^2) of buildings across Europe can lead to deviations of up to 25%.

- **Algorithms, and not real data, produce most of the current energy efficiency investment numbers in Member States at the present time.** For example, in France Certificats d'Economies d'Energie (CEE) (cumulative and present value of kWh saved) were developed 15 years ago, however the sum of today's CEEs doesn't describe the actual energy consumption at all.

There are three categories, which should be distinguished in our data strategy, because their data structures differ strongly: public investments, investments by financial institutions, and private investments by asset owners (from savings or internal cash flow).

- Multiple data sources from different funders can complicate calculations and compound the error rates resulting in over- or under-counting: e.g. for a house renovation, where 50% funding is taken from a national fund and 50% is funded privately. If only the publicly funded 50% investment shows up in a data collection, it will significantly underestimate the full investment. The proper collection of full investment will be lost if data collection is neither predefined by the program itself nor collected on a granular basis. Double counting is also easily created if both the public and private funders count 100% of the investment in their reporting.

- In the case of Ministries, national statistical authorities and specifically Department for Business, Energy & Industrial Strategy (BEIS) in the UK, one of the challenges is that while significant data is available, it does not provide a clear view of economy-wide levels of energy efficiency investment. Often home renovations are funded from cash savings and therefore very hard to track.

- One way to correlate specific information to wider market activity – on energy efficiency investments – is based on spending on energy efficiency technologies such as triple- or double-glazed

windows or insulation from large market retailers and wholesale suppliers. However, WG members suggest that they are not interested in recording or sharing this information. Also, it is hard to say if the technology is sold to an intermediary's warehouse or to an end retail customer. In insulation, the major part of sales is to trade and not directly to retail.

Key presentations

Throughout the WG meetings several experts have been providing valuable insights to the working group. In particular, we would like to mention here the following experts:

Name of presenter	Title of presentation	Description of presentation
Yannick MONSCHAUER (IEA)	Recent IEA numbers and methodology elements	A presentation of the results from the IEA's World Energy Investment report 2021 to update the Working Group and provide insights into the methodology that is applied by the IEA.
Paul ROSANE (CPI Global), Rajashree PADMANABHI (CPI Global)	Global Landscape of Climate Finance 2021 and the upcoming Tracking Energy Efficiency in buildings	Overview of the methodology of CPI to track the finance flow of energy efficiency investments.
Aleksandra NOVIKOVA (IKEM)	Assessment of current investment vs investment need. Lessons from Germany, Latvia and Czechia	Presentation of in-depth cases studies in different countries, particularly showing that a harmonisation across the EU data collections is needed.
Clemens ROHDE (Fraunhofer ISI)	Introduction into the DEEP database	Overview on the DEEP database as a benchmarking tool to track energy efficiency

Name of presenter	Title of presentation	Description of presentation
		investments from a bottom-up approach.
Nick KEEGAN (EEVS)	Introducing the UK Energy Efficiency Trends survey and latest results	A presentation of a UK survey with the objective to stimulate energy efficiency investments, while collecting expectations on, among others, costs, technologies deployed and spending volumes.
Raphael JACHNIK (OECD)	Measuring the alignment of real economy investments with climate mitigation objectives	Based on case studies in several countries, the OECD found that aggregate energy efficiency numbers cannot be matched to total energy consumption and that a granular data collection would be needed.
Hadrien HAINAUT (I4CE)	Tracking EE investment, funding patterns and the investment gap in France	A presentation of the I4CE climate investment studies, revealing that, among others, a standardisation in reporting of financial institutions makes it difficult to aggregate data across different sources to ultimately determine the overall investments and investment gaps.
Peter SWEATMAN (Climate Strategy), Maurizio YRIVARREN (Climate Strategy)	Review of energy, buildings, and energy efficiency data in Eurostat	Presentation of the current available energy efficiency data in Eurostat, particularly highlighting that the granularity is not yet sufficient and its quality heavily relies on the

Name of presenter	Title of presentation	Description of presentation
		quality of the national accounting systems.
Sven JANTZEN (SkenData)	Access to multiple data sources for carbon and energy efficiency indication	To determine Energy Performance Certificate (EPC) labels and the possibility to optimise for energy efficiency of buildings, SkenData has developed a method to create a "digital twin" of the buildings based on publicly available data.
Didier BOSSEBOEUF (Ademe, Coordinator of Odyssee-Mure)	Presentation on Odyssee-Mure database	Odysee-Mure is a EU-funded database introduced to monitor the progress on energy efficiency investments by collecting both indicators and policy information.
Debora REVOLTELLA (EIB), Peter HARASZTOSI (EIB)	Presentation on EIB Investment Survey	The EIB Investment Survey covers for 12.000 interviews within the EU and collects, but is not limited to, data from energy efficiency investments.
Simon BENNET (IEA)	IEA – Energy Efficiency Investment tracking methodology and challenges	IEA compares the projected energy efficiency investments grouped by different scenarios (existing policies, pledges made and net zero). However, the analysis is grouping different countries together since granular data is not available.
Stoyan DANOV (CINME)	EN-Track – an Energy Efficiency Performance	As a Horizon 2020 project, EN-Track combines information from DEEP, Utility data

Name of presenter	Title of presentation	Description of presentation
	Tracking Platform for Benchmarking Savings and Investments in Buildings	and cadastre data to allow for detailed analysis of the energy investments and consumption. The prototype is based on two countries (Spain and Bulgaria).
Moritz KIESE (d-fine)	EuroDat – the first European data trustee based on the European Gaia-X initiative for sharing ESG and energy related data	Moritz introduced the EuroDat concept – a new approach to data collection, where participants remain owners of the data and may therefore be incentivised to provide more data to collections. This is currently used to set up a collection of energy efficiency data for SMEs.

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