Pilot Study: Collaboration of Financial Institutions with Digital Energy Management Service Providers

PCAF PROJECT FINANCING TOWARDS NET-ZERO BUILDINGS

JUNE 2024

PCAF Partnership for Carbon Accounting Financials

Contents

1. Introduction

The Partnership for Carbon Accounting Financials (PCAF) is an industry-led initiative, advising financial institutions (FIs) on how they can measure and disclose the greenhouse gas (GHG) emissions associated with their financial activities. Buildings account for 37% of European greenhouse gas (GHG) emissions. Therefore, decarbonization measures in existing buildings need to increase drastically. At the same time, new buildings need to lead the way towards zero emissions. Funded by the Laudes Foundation, the PCAF project "Financing towards net-zero buildings" addresses the need to mobilize the financial industry to decarbonize their commercial real estate and mortgage portfolios and thus accelerate the transition of European buildings towards net zero by 2050. The project commenced in July 2021 and provides guidance to financial institutions to stay on the required course towards net-zero.

Measuring emissions in the real estate sector poses significant challenges. Unlike industries with well-defined emission sources, real estate encompasses a diverse range of source activities, across residential, commercial, and industrial properties, each with its own unique characteristics and energy consumption patterns. PCAF would like to build on the momentum of measurement and disclosure to offer financial institutions enhanced approaches to increase the precision of financed emission measurement. For the accounting of operational emissions, FIs often rely on average emission factors, energy performance information from Energy Performance Certificates (EPC) and proxy data. Over time FIs should aim to move towards more granular and accurate measurement approaches to increase the precision of financed emissions measurement. To support financial institutions in their emissions measurement journey, PCAF explored pilots on different measurement approaches, that may enable FIs to access actual measured data.

In October 2023, PCAF published an action paper, which documented existing and upcoming approaches that capture actual measured data and could potentially support FIs in improving their measurement abilities by accessing energy consumption data of their buildings portfolio. While access of data to enable actual measurement is still a significant challenge, numerous initiatives attempting to obtain actual or near-actual emissions measurements, across public, private sectors and academia were identified (e.g. digital building passes, digital twin models). Initiatives covered in the action paper included the German savings bank association DSGV, Fabriq, Kamma, Sero, Eliq, Measurabl, Metrikus, Smart Energy Research Lab (SERL) at University College London (UCL), Better Buildings Partnership, Data for Good, Dutch Central Bureau of Statistics and OSB Group.

Subsequently, the initiatives from Eliq and SERL were chosen to develop in-depth data pilots. These two organizations were chosen since they showcase a high level of application maturity and take two separatet perspectives within the measurement ecosystem. As a commercial data management system service provider, Eliq deploys a nearest neighbor model to reflect actual measurements for their clients. The UCL initiative collaborates with the UK government to gather smart meter data from UK homes and derive insights for research purposes. The PCAF pilot studies further explored the two approaches and their potential applicability to support European FIs in accessing actual measured data for precise GHG measurements. While focusing is put on European countries, the potential collaborations and use case may also be applied in countries outside of Europe, if the respective data supply chains is set-up.

This strategy report provides the synthesis of the pilot study conducted in collaboration with Eliq. Eliq uses actual measurements from smart meters as well as synthetic load profiles to estimate comparable buildings (e.g. similar location, building type, age and demography) to create insights into energy consumption of residential buildings in actual use.

As a collaboration partner, Eliq contributed to this report by sharing insights into their operating model as well as their data supply chain structure. Furthermore, an exchange with a financial institution, currently collaborating with Eliq, was facilitated. The use cases that Eliq currently offers to FIs have been used as examples in discussions with interested FIs, to showcase potential application in their context. Therefore, this report relies on the use cases and experiences shared by Eliq. Where possible, other operating models and service providers have been considered and are referred to in relevant sections. PCAF does not provide any commercial recommendation nor any substantiated claim on the quality of the data, information or approach that Eliq or any other service provider is deploying. We do not have commercial arrangements nor endorse Eliq or any other party as a service provider.

The aim of this report is to analyze the application potential of modeling capabilities for building energy performance, as offered by Eliq, for use by FIs across Europe. The report starts with outlining an illustrative data supply chain of data management system providers and provides insight into the operation model of Eliq. In chapter 3, the three different use cases currently deployed by Eliq are explained in detail. These use cases have been generalized to serve as general examples for how services provided by data management system operators could collaborate with FIs. They have been expanded by desktop research and conversations with other FIs.

Since local boundary conditions may substantially influence the replicability of certain data supply chains and services, an overview of the application potential of the use cases in different European country contexts is provided in chapter 4. For this purpose, three European countries, namely Denmark, Germany and Spain were chosen to assess the economic, political and technological boundary conditions. The countries were selected to consider different European geographies and local boundary conditions, ranging from more challenging conditions, as is currently the case in Germany, to more favoring conditions, as in Denmark or Spain. The report ends with conclusions and recommendations on how FIs could consider the different use cases and necessary boundary condition in their decision-making and customer engagement strategies.

It should be noted that the guidance and recommendations provided in this report do not form part of the PCAF Standard, and there remains no requirement from PCAF nor is this aimed at promoting a particular service provider acting in the name of PCAF. This report is meant for FIs who want to become more familiar with the potential options on including actual energy measurements of buildings in their reporting and customer service.

We would like to express our gratitude towards the Laudes Foundation and its Built Environment Team; the Core Project Team of this project, that includes ASN Bank, ABN AMRO, Carbon Risk Real Estate Monitor (CRREM), Green Finance Institute (GFI), Luminor Bank, Nordea Bank, Deutsche Bank, Erste Group, Federated Hermes, OakNorth Bank and Bank of Cyprus; and the Expert Advisory Group of this project, that includes Alliance for Sustainable Building Products (ASBP), Architecture2030, Center for Climate-Aligned Finance, Climate Safe Lending Network (CSLN), Energy Efficient Mortgages Initiative (EEMI), European Confederation of Woodworking Industries (CEI-Bois), European Insulation

Manufacturers Association (Eurima), European Panel Federation, Global Alliance for Buildings and Construction (GlobalABC), Global Buildings Performance Network (GBPN), Green Digital Finance Alliance, GRESB, InnovaWood, Institutional Investors Group on Climate Change (IIGCC), natureplus, Passive House Institute (PHI), Renovate Europe, Science-based Targets initiative (SBTi), UN Environment Programme (UNEP), World Business Council for Sustainable Development (WBCSD) and World Green Building Council (WorldGBC). Furthermore, we would like to thank our project collaborators SERL and Eliq.

2. The data supply chain

For FIs to access the emissions of their building portfolio, the actual energy consumption data of a building unit by fuel type needs to be measured, collected, transferred, processed and used in application, for instance for reporting or generating insights at the receiving end. This requires a data supply chain to be set up. The data supply chain forms the basis of a data management system for energy measurements. The figure below (Figure 1) provides a schematic overview of a data supply chain for data management system providers. This overview is developed based on insights gained through the pilot study conducted on Eliq. The components and different entities involved in the data supply chain will be described in the following sub-sections.

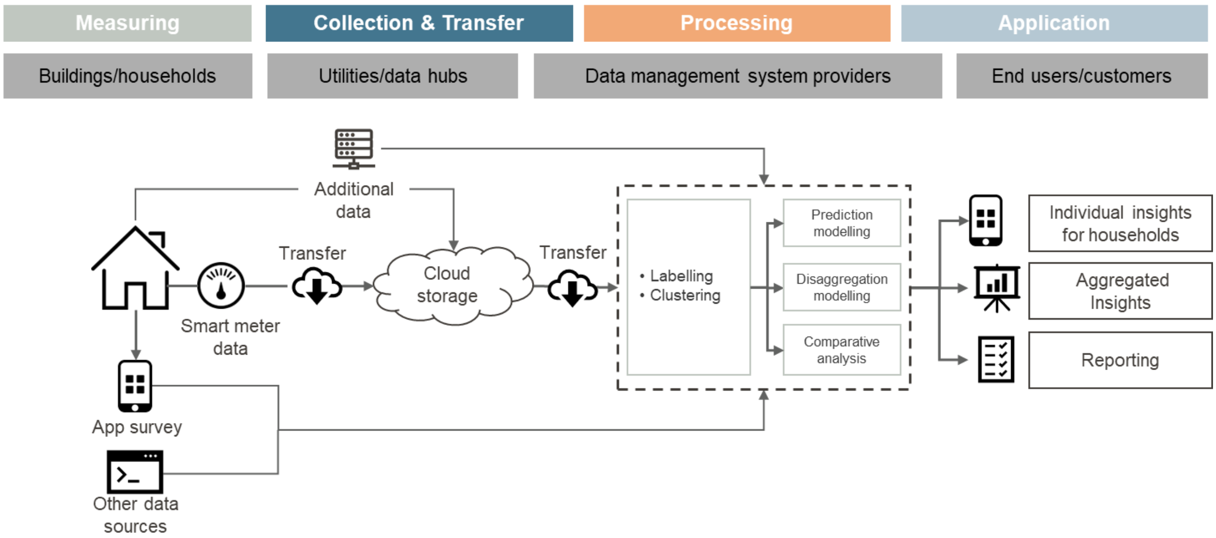

Figure 1: Example of a data supply chain for data management system providers (Source: own illustration)

2.1 MEASURING

The first step in the data supply chain is the measurement of the energy consumption of residential and non-residential buildings. Energy consumption in buildings originate from different unregulated and regulated household fittings and equipment, where heating and cooling are examples for regulated energy, while external lighting, electric appliances and IT equipment are examples for unregulated energy (BREEAM 2016).

Depending on the source for energy consumption, different ways of measuring the energy consumption can be used. As depicted in Figure 2, these methods can range from 1) intrusive technologies such as smart plugs, installed at each of the energy consuming appliances individually, to 2) centralized smart meters collecting energy consumption profiles of each entity, to 3) aggregated information on energy consumption from the energy bill of buildings (Ridi et al. 2014). Smart meter measurements offer the highest potential for a continuous measurement approach for energy consumption assessments that is non-intrusive, and therefore easily scalable (Frauenhofer 2020).

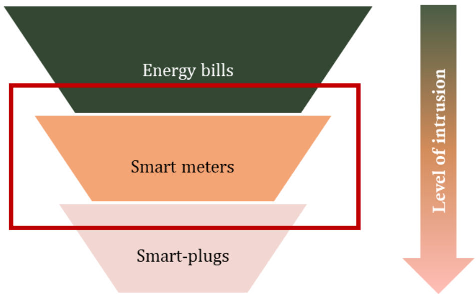

Figure 2: Different ways of assessing energy consumption in buildings (Source: own illustration).

The actual amount of energy consumed is dependent on fixed and variable factors. Fixed factors (e.g. the building envelope, level of insulation) can only be impacted by considerable efforts in the design, construction, and renovation phases of a building (Asdrubali and Desideri 2018). Variable factors concern the actual use of energy and are impacted by demographic, technological and behavioral factors (Abrahamse and Steg 2011). Therefore, the more information is available on an individual building, occupancy and use pattern, the more accurate data processing and insight generation can be.

In the operating model of Eliq, energy insights are generated based on primary data provided by installed smart meter technology, combined with secondary data on household characteristics such as (heated) floor area, number of residents, address, year of construction etc. Eliq retrieves the primary data through collaborations with data collection entities such as utilities and data hubs. Secondary data is retrieved both from data collection entities such as data hubs and Distribution System Operators (DSOs), as well as through a questionnaire from the households/end users. The additional information from the households/end users is obtained through an energy insights application designed by Eliq, which end users can use to receive insights on their individual energy consumption. Registering for this application requires the end users to fill out a questionnaire on their household characteristics.

2.2 COLLECTING & TRANSFERRING

The rollout of smart meters in European countries may differ per market but is commonly conducted by DSOs, which are supervised by regulators. In most cases, DSOs continue to own and operate the smart meter after installation (EC 2021). In countries such as the UK, the smart meter rollout is conducted by the suppliers.

In many European countries, energy consumption data from smart meters is collected either by utilities or by (retail) data hubs, which are entities with the specific purpose to provide access to and exchange meter data.

The frequency of meter readings varies across Europe. The measurements can be as granular as minute to hourly readings. Additionally, it can span back to several years in the past (EURELECTRIC 2013). As depicted in Figure 3, the data can be collected and transferred via a smart meter communication port (P3), which serves the DSOs mainly for meter readings, power quality and outage measurements. Data collected from the P3 port can also be accessed via the P4 port, which is the gateway for energy suppliers and internet service

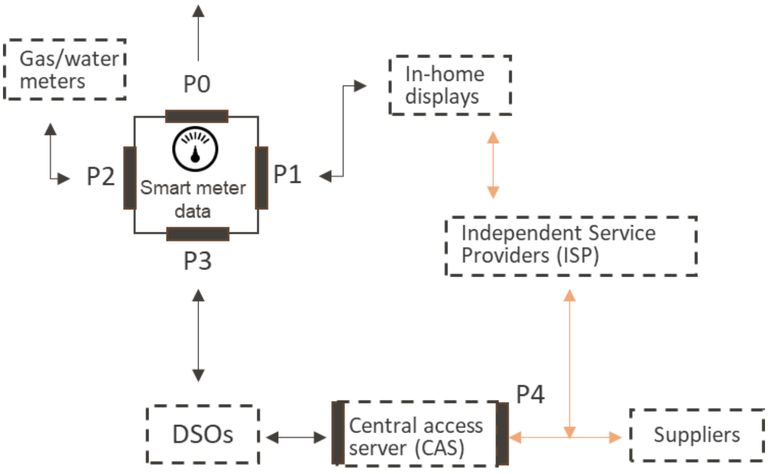

Figure 3: Overview of smart electricity meter ports and processing steps (Source: adapted from van Aubel and Pol (2019))

providers (ISP). Through this port, energy consumption data is accessed by third parties and stored in data hubs. In cases where consumption data is not proactively stored in a central data hub and is only stored in the smart meter, energy suppliers or ISPs have to submit requests to gain access to this data (van Aubel and Pol 2019).

(Retail) data hubs are centralized data centers that enable the exchange of energy consumption information between market parties. These hubs help to secure equal access to data from smart metering and increase efficiency in the communication between market parties, especially between network operators and retailers for billing and switching purposes (van Aubel and Pol 2019).

To date, several European countries have implemented national data platforms that cover different Business Use Cases (BUCs)[1] and System Use Cases (SUCs)[2]. For example, data platforms in countries such as the Netherlands and Estonia are end-consumer oriented, while platforms in Belgium and Italy are more focused on suppliers and Balancing Responsible Parties (BRPs)[3]. These different orientations can lead to varying prerequisites for the data collection and processing steps by third parties. Most commonly, data platforms are owned and operated by Transmission System Operators (TSOs) and DSOs (EC 2021). In some European countries such as Germany, where central data hubs are not (yet) in place, smart meter gateways are used to receive and store data from meters as well as communicate retailer energy consumption data with external market participants (BSI 2024). Each consumer can define which market party has access to their smart meter data, resulting in a highly decentralized data management system (EnergyPost 2017).

In Eliq's operating model, the company acts as a sub-processor for utilities and data hubs. This means that data is sent directly to Eliq through an Application Programming Interface (API), either set up by Eliq's customer or by Eliq. If available, data such as addresses, and any

[1] BUCs are business services for a commercial end-user outside of the energy system.
[2] SUCs are use cases for the development and regulation of the energy system.
[3] BRPs are organizations that are responsible to invoice energy consumption per household/party.

other household characteristics are provided to Eliq through their APIs with their collaboration partners. The data is then aggregated and anonymized for processing.

2.3 PROCESSING

After receiving the primary and secondary data from households, utilities and clients, the service provider processes the data within its individual modeling environment. This step in the data supply chain requires specific attention, as it can be seen as the most crucial step to translate energy data into meaningful outcomes, but also introduces subjective data analysis steps that depend on the decisions and set-up of the deployed methods and models.

In Eliq's case, the data is uploaded to the internal Eliq platform and labeled, e.g., by energy source/carrier, address etc. Subsequently, the data is further processed through algorithms which cluster and clean it. Depending on the use case, the datasets are further processed or used as model inputs for:

- **Disaggregation:** Disaggregating the signals, e.g., of different appliances.
- **Consumption insights:** Clustering and visualization of energy consumption.
- **Comparative insights**: Comparison of different energy consumption patterns.
- **Prediction of future consumption:** Estimating future energy consumption patterns.
- **Prediction of comparable buildings:** Imputing energy consumption of households, where no measurement data is available. For this, a nearest neighbor modeling step is conducted, in which households are matched, based on GPS location, regional climate and house type.

Generally, energy consumption prediction models can vary significantly in their transparency and quality of the data analytical process. In particular when aiming to predict energy consumption of buildings, two main aspects can impact the accuracy and quality of outcomes significantly (Olu-Ajayi et al. 2023):

- Quality and comprehensiveness of the baseline dataset of actual measurements
- Quality of the applied prediction algorithm (e.g. through supervised learning).

Additional secondary data that is fed into the model can increase prediction accuracy. For instance, Eliq finds in their model assessment that the addition of the Energy Performance Certificates (EPCs) of a building significantly increases accuracy of the predictions and imputation (Eliq 2024). An EPC is an energy efficiency label which runs from A to G. A is considered the most efficient rating and G the least efficient. EPCs contain energy efficiency information on the building and are useful to estimate actual energy consumption. Since the mandatory use of EPC labels differ per country and building type, the coverage of EPC labels can also vary significantly at a regional level. Parameters and other considerations that should be considered when assessing the quality of a model are summarized under section 3.1.2.

2.4 APPLICATION

The processed data can be used for different BUCs and SUCs. The use cases most relevant to FIs are described in more detail in the subsequent section.

3. Collaboration use cases for financial institutions

3.1 USE CASE: PCAF CARBON ACCOUNTING

A potential use case for the collaboration of FIs with energy data management platform providers is to enhance their understanding of the actual energy consumption of their mortgages and commercial real estate portfolio. This knowledge can be utilized to calculate the emissions related to energy use of mortgages and CRE, as described under the PCAF Standard "The Global GHG Accounting and Reporting Standard for the Financial Industry - Part A Financed Emissions" (PCAF 2022).

Utilizing Eliq's operating model as an example, the first step for this use case is a contractual agreement, including a Non-Disclosure Agreement (NDA), between an energy data management platform provider and an FI. The platform provider typically acts as a sub-processor under these agreements. Subsequently, the energy data management platform provider sets up a client specific Application Programming Interface (API) to receive the data on the FI's mortgages or commercial real estate portfolio, including information such as addresses and data on fixed and variable building characteristics (e.g., type of use, location, floor area, EPC label, number of inhabitants). The energy data management platform provider then conducts a data labeling and cleaning step. Subsequently, the data is fed into a model in which various prediction and data manipulation steps are conducted, such as matching exercises with available smart meter data.

In Eliq's case, a nearest neighbor model is applied to predict the energy consumption of all buildings in the building portfolio. The model uses a set of meter readings as input, which Eliq retrieves from utilities and/or data hubs. The nearest neighbor model uses addresses and additional household characteristics specific to the FI's building portfolio, as input to the algorithms. Therefore, actual measured metered data is used as ground truth data[4], and predictions are made for all buildings in the portfolio. While Eliq's models do have the capability to also facilitate direct matching of actual energy consumption with the smart meter readings for buildings, in most cases the share of smart meter data that is available to Eliq for the households in a portfolio is limited to a maximum of 5%. This often makes the additional effort to facilitate a direct matching step unfeasible. Direct matching capabilities, however, have the potential to improve the data quality and accuracy of reporting, as some of the more arbitrary data manipulation and prediction steps can be reduced in such cases. With growing smart meter coverage in many European countries as well as growing interest from utilities and data hubs to create more business use cases, the feasibility of this step may increase over time.

In specific local contexts, a direct matching appears to already be feasible. For instance, the service provider EDSN, operating in the Netherlands, can provide their service based on direct matching. In this case, due to current data privacy laws, the final data is handed to the FIs in an aggregated format, e.g., based on zip-code or building type level (PCAF internal interview 2024)

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[4] Ground truth data can be defined as data that is provided through empirical evidence (i.e. direct measurement or observation)

Service providers experience growing interest by FIs to explore these capabilities while also experiencing certain challenges to scale their service. To date, multiple successful collaborations have been set-up by Eliq and other service providers across Europe. However, considering various local regulatory and technologic boundary conditions (see further analysis in section 4), uncertainties on the data quality and assurance hamper FIs from utilizing these services. Clear guidance on boundary conditions for these approaches by internationally recognized standards could support FIs in further developing such collaborations, e.g. through the data quality score of the Global GHG Accounting & Reporting Standard for the Financial Industry by PCAF. This potential will be further scrutinized in the following section.

3.1.1 PCAF DATA QUALITY SCORE

The use case described above can assist FIs while reporting their financed scope 3 emissions under the reporting standard for the mortgages and commercial real estate asset classes. Extended guidance on the data quality score of emissions data, derived from modeled or estimated values but based on actual measured energy data, could support FIs in making decisions on the type of data collection to focus on, with the goal of improving their data quality score.

Generally, the data quality score for data provided through service providers could range from score 1 to score 5, depending on the processing steps and data characteristics of the data, as described in Figure 5.

If actual measurement data (primary data) is available for the buildings in the portfolio, data quality scores 1 and 2 can be reached[5]. To reach a data quality score 1 or 2, metered data for each individual building in the portfolio and average or supplier specific emission factors would be needed. This aspiration may theoretically be feasible if the accounting is fully connected to individual household measurement activities of the FI's customers.

For calculated emissions based on the estimated building energy consumption, the data quality score would range between quality score 3 to score 5. While focusing on the provisions under score 3, three potential scenarios are possible regarding estimated building energy consumption per floor area based on actual measurement data:

- **Scenario 1**: Predicted/modeled data can be shown to be *equal* to an estimation of emissions based on official building energy labels.
- **Scenario 2**: Predicted/modeled data can be shown to be *more accurate or reliable* than estimations of emissions based on official building energy labels.
- **Scenario 3**: Predicted/modeled data is shown to be *less accurate or reliable* than estimations of emissions based on official building energy labels.

EPC labels themselves can differ significantly in quality between different geographies and building categories, which complicates the comparison over regions.

[5] Quality score 1 and 2 also apply if the data is collected based on the actual consumption but aggregated by the data provider before being delivered back to the FI.

Table 1: Current PCAF quality score for mortgages and commercial real estate (PCAF 2022).

Data quality	Options to estimate the financed emissions		When to use each option
Score 1	**Option 1: Actual building emissions**	1a	**Primary data on actual building energy consumption** (i.e., metered data) is available. Emissions are calculated using actual building energy consumption and supplier-specific emission factors[6] specific to the respective energy source.
Score 2		1b	**Primary data on actual building energy consumption** (i.e., metered data) is available. Emissions are calculated using actual building energy consumption and average emission factors specific to the respective energy source.
Score 3		**2a**	**Estimated building energy consumption** per floor area based on official building energy labels AND the floor area are available. Emissions are calculated using estimated building energy consumption and **average emission factors** specific to the respective energy source.
Score 4		**2b**	**Estimated building energy consumption** per floor area based on building type and location-specific statistical data AND the floor area are available. Emissions are calculated using estimated building energy consumption and average emission factors specific to the respective energy source.
Score 5	**Option 3: Estimated building emissions based on number of buildings**	**3**	Estimated building energy consumption per building based on building type and location specific statistical data AND the number of buildings are available. Emissions are calculated using estimated building energy consumption and average emission factors specific to the respective energy source.

Based on an assessment of the capabilities of energy management modeling offerings of service providers in Europe, it can be concluded that the quality and depths of various providers' methodologies can differ significantly. Some energy management providers like Eliq may be able to showcase that their predicted/modeled data is more accurate than estimations of emissions based on official building energy labels. Other providers may not yet have the amount of necessary actual measurements to showcase this statistically. To better reflect the role of modeled data in the PCAF quality scoring, the scoring could potentially be refined by a more explicit guidance of modeled data under score 3. This could potentially entail an addition to score 3 such as:

[6] Supplier-specific emission factor is an emission rate provided by the energy supplier (e.g., utility) to its customers reflecting the emissions associated with the energy it provides (e.g., electricity, gas, etc.). Average emission factors represent the average emissions of the respective energy sources occurring in a defined boundary (e.g., national or subnational).

Estimated building energy consumption per floor area based on official building energy labels AND the floor area are available **OR estimated building energy consumption per floor area based on actual measurements AND the floor area are available.** Emissions are calculated using estimated building energy consumption and **average emission factors** specific to the respective energy source.

The following section provides an overview of proposed quality parameters that should be considered to enable FIs to apply a score 3 rating.

3.1.2 DATA AND MODEL QUALITY PARAMETERS

The quality of modeled energy consumption of a building is highly dependent on a few variables. Therefore, the proposed addition of quality score 3 can be supported by quality parameters that are to be considered to ensure a sufficient model quality. For this, a combination of quality parameters for the ground truth data as well as the model itself should be considered as listed in the following table:

Table 2: Potential quality parameters for data quality score 3 for mortgages and commercial real estate under Scenario 1.

Parameter	Potential requirements
Ground truth data	
Number of datapoints	The estimated energy consumption is built on statistically relevant ground truth data that is based on historic, actual energy consumption and reflects the respective building/building type, energy mix and other building characteristics.
Recency of measured input data	The ground truth data (i.e. actual energy consumption data) is as recent as possible.
Representativeness of other building characteristics	The ground truth data is representative of the characteristics of the building in terms of time, geography (incl. building location), building type, year of construction as well as type of energy sources, type of occupants (incl. demographics), number of occupants, usage patterns (e.g. time of user in the building per day) as well as EPC label (if available). (GHG Protocol 2004)
Model	
Statistical analysis	For the applied model, a report on the measurement and estimation uncertainty for instance in accordance with the “GHG Protocol guidance on uncertainty assessment in GHG inventories and calculating statistical parameter” (GHG Protocol 2005) is provided.
Quality management system	An inventory quality management system is in place and transparently reported (GHG Protocol 2004).

3.2 USE CASE: INCREASING ENERGY EFFICIENCY OF END USERS

The second use case for FIs to collaborate with energy data providers is to enable their customers to gain insights into individual energy consumption on an hourly or daily resolution. This can increase the customer's awareness of their energy consumption and provide clarity regarding potential measures to increase their energy efficiency.

Eliq offers an application to the customers of FIs. The user journey starts with the customer's registration on a platform or application to retrieve energy insights. The household's energy measurement data needs to be provided to the energy management system provider. If customers have accessible smart meters, Eliq creates energy insights through actual measurements (with consent). If the customers do not have accessible smart meter data, they receive estimated daily consumption insights based on modeled predictions.

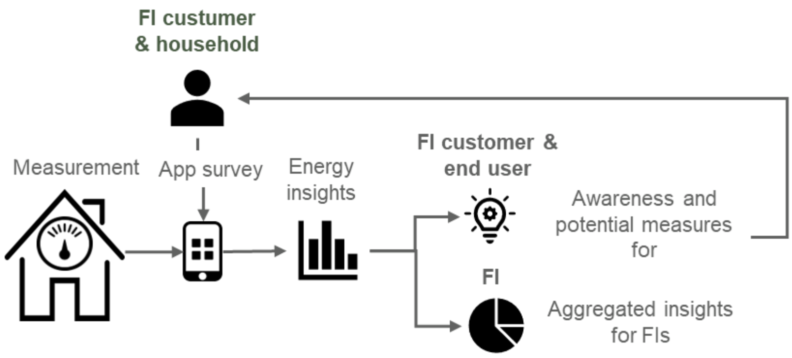


Figure 4: User journey for FI customers using an energy insights app/platform (Source: own illustration).

Furthermore, customers can include additional information on household characteristics and consumption patterns to the application. This information can be used to create additional insights such as:

- Comparison of energy use to EPC label
- Comparison to buildings of similar size, comparable use pattern or demography
- Consumption peaks
- Appliance categories that consume the most amount of energy

FIs can make use of this service in two ways:

(a) They can provide their customers with the possibility to track their daily energy consumption and support them in their energy efficiency efforts, and
(b) They can gain insights into the energy use patterns of their financed emissions in mortgages and commercial real estate portfolio.

3.3 USE CASE: IMPROVING GREEN FINANCE PRODUCTS

The third use case is focused on the use of data management service providers in the context of green finance products, which FIs can offer to their new or existing customers. A partnership with a data provider can help FIs improve their sustainable finance products' performance and uptake. A potential application of this could be the creation of a complete user journey for their customers based on generated energy insights. An illustrative user journey is outlined in Figure 5.

As described in the previous section, energy management service providers can create energy insights for both FIs and their customers. Providers like Eliq are currently exploring ways to connect these insights to improvement recommendations, which can be provided to the users through the application or platform. Other energy insight application providers, such as Toon, already offers similar applications (Toon 2024).

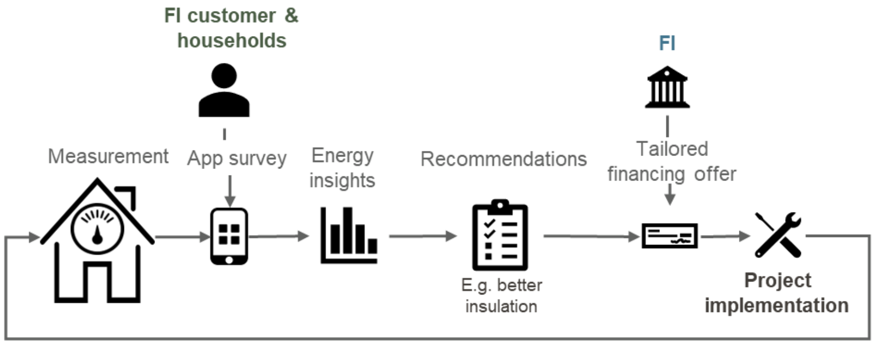


Figure 5: User journey for FI customer with extension of green finance products (Source: own illustration)

Such an energy advisor service can educate end users on recommendations for "next best actions" on energy saving tips and home energy retrofits that are relevant to the household, such as:

- Upgrading buildings' insulation to reduce heat loss.
- Installing a renewable energy source (such as solar panels)
- Installing a smart energy management system in the house
- Exchanging heat sources
- If appliance level breakdown data are available, the replacement of certain appliances could also be recommended.

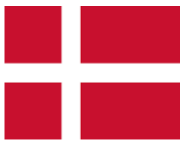
Based on the received information, FIs can clarify and streamline the user journey by ensuring that their customers are evaluated and allocated the correct procedure and contacts for the respective financial product. Depending on these insights and recommendations, FIs would be able to offer tailored services to the user, e.g., through green loans for the type of investment needed as well as potential information on subsidies and grants that could be used to support the implementation of measures. FIs can encourage the adoption of their financial and non-financial products by educating existing and potential customers on their proof of outcome and expected return on investment through the application.

4. Country specific collaboration potential

The potential for collaboration between energy data management platform providers and FIs may vary between European countries due to their smart meter roll out rate, data infrastructure and other boundary conditions, such as data protection laws. Therefore, in the following section, three different European countries are assessed to gain a better understanding on how these boundaries conditions may impact the scaling of such collaborations. The countries were chosen to showcase a range of different European geographies as well as local boundary conditions from more challenging conditions, as is currently the case in Germany, to more favorable conditions as currently in Denmark or Spain. While this assessment focuses on European countries, collaborations and use cases may also be applied in countries outside of Europe, if the underlying data supply chains exist.

4.1 DENMARK

4.1.1 COUNTRY FACTSHEET



Denmark

Share of households with smart electricity meters installed, % (FfE 2023)

100%

Near-term target

100% smart gas meters for buildings with district heating by 2027 (Leiria et al. 2021).

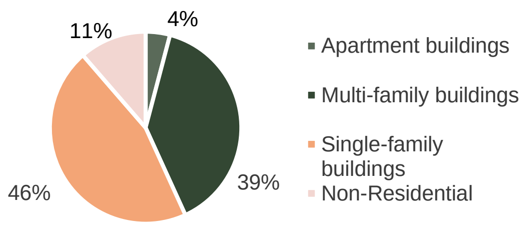


Figure 6: Building Stock, source: BSO (2024)

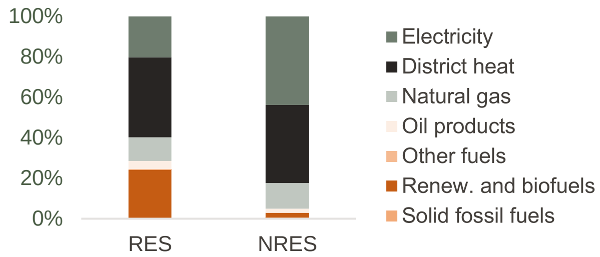


Figure 7: Share of fuels in final energy consumption of residential (RES) and non-residential (NRES) sector, source: Eurostat (2024)

Smart meter rollout

In 2013, the Danish Parliament announced that by the end of 2020, all electricity consumers in Denmark should have smart meters (Smart Energy International 2013). In 2019, Denmark achieved 80% coverage through the installation of 1 million remotely read electricity meters through the Danish energy company, Radius-Kamstrup cooperation, while meeting all safety standards and budget requirements (Tripica 2023). By 2021, Denmark met its 100% smart meter uptake target.

In Denmark, it will also be mandatory for collect heating data with smart meters for every building connected to the district heating gird from 2027. District heating provides most energy uses for space heating and domestic hot water in Danish buildings and will be a key lever for transitioning to a low carbon society (Leiria et al. 2021).

Data Protection	The Danish Data Protection Act is the national legislation that governs the processing of personal data. The Act applies to smart meter data which is considered personal information and governs how this data can be processed and shared. Although the Act imposes restrictions on information flows, it is known to be relatively lenient in sections about processing information in a statistical, historical, or scientific way. Danish universities have agreements with the Data Protection Agency allowing researchers to easily bypass notification requirements for information processing. The leniency and agreements allow researchers to feel reassured that their processing of information is in full compliance with the Act (Tureczek 2016).The EU data protection directive which came into full effect in 2018 has created more stringent compliance requirements across the EU. The legislation addresses the processing of personal information by EU institutions and extends principles of data protection established in the General Data Protection Regulations (GDPR) to these entities (EC 2018).
EPC	Energy-labeling of buildings in Denmark is mandatory. The aim is to promote energy savings by visualizing the amount of energy usage by individual buildings. In Denmark, the energy-labeling scale runs from A to G where A is divided in A2020, A2015, and A2010. A2020 labels are low energy buildings which consume a minimum of energy while G-labeled buildings consume the most. (Danish Energy Agency 2024). All EPCs are registered in a central database hosted and administered by the DEA and are publicly available (Energystyrelsen 2024).
Data collection	The Distribution network operator (DSO) is responsible for data collection and management. The DSO can use smart meter data for billing, internal statistics, or historical processing. This data can only be collected with explicit, specified, and legitimate purposes. In Denmark, Energinet is the national transmission and distribution operator which transfers electricity consumption information to Statistics Denmark. Energinet leverages DataHub to store Danish electricity consumption data. DataHub has enabled uniform communication and standardization to support the interaction between players in the electricity market (European Smart Grids Task Force 2016). End users do not have direct access to DataHub but can access their information through a web portal.
Energy performance modeling services	Denmark aims to lead the way in energy efficiency, demonstrating innovative solutions to improve energy efficiency (State of green 2023). Denmark aims to take a holistic approach in sustainable energy renovation through the DNGB certification which provides a benchmark for evaluating the sustainability of buildings (KLP Ejendomme 2024). EnergiNet and Statistics Denmark work in tandem to model energy performance in Denmark. Some software providers seem to operate in the country such as IES Energy Modeling Software, which can be used to predict building energy consumption, CO_2 emissions, peak demands, energy cost and renewable energy production.

4.1.2 ASSESSMENT AND CONCLUSION

An assessment of the factsheet indicates that favorable conditions exist in Denmark for scaling collaborations between data management service providers and FIs. The following conclusions can be drawn:

- **High smart meter penetration rates:** Denmark has achieved widespread deployment of smart meters and is planning to ensure 100% coverage of smart gas meters by 2027. This ensures a robust infrastructure for real-time energy data collection.
- **Centralized collection system:** Denmark has developed a sophisticated data management system, which is centrally deployed and governed by the Danish TSO, Energinet. Third party energy management system providers are therefore dependent on collaboration with Energinet to receive necessary data access. The use of such data is limited to explicit, specified, and legitimate purposes and is primarily used within the electricity market and for research purpose.
- **Consumer access to individual data**: Consumers have the ability to access their energy data and share it with third parties through a data hub. This consumer-friendly approach encourages collaboration with third party service providers on an individual basis.
- **High level of EPC label adaptability**: As energy labeling of buildings in Denmark is mandatory, there is high coverage of available energy performance data for buildings. Furthermore, the centralized EPC database enables direct access to building specific EPC labels.

Regarding potential use cases for collaborations between FIs and energy data management service providers, use cases 2 and 3 appear to be the most favorable under current boundary conditions in Denmark. Since access to data is granted for each household, service providers can engage with customers of FIs in a direct way, accessing their data and providing them with energy insights. This allows FIs to offer tailored financial products and services. For use case 1, access to a larger set of smart meter data for commercial purposes would need to be channeled through the DSO and a data hub, which may involve more elaborate cooperation agreements and contractual conditions.

4.2 GERMANY

4.2.1 COUNTRY FACTSHEET

Germany

Share of households with smart electricity meters installed, % (FfE 2023)

1%

Near-term target

95% smart meter coverage by 2030 (FfE 2023). No targets for the use of gas smart meters.

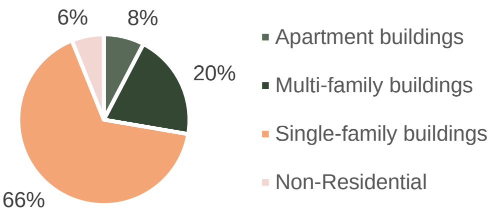


Figure 8: Building Stock, source: BSO (2024)

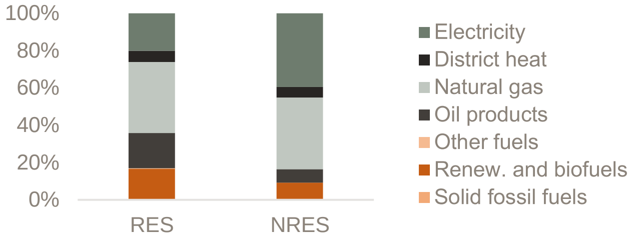


Figure 9: Share of fuels in final energy consumption of residential (RES) and non-residential (NRES) sector, source: Eurostat (2024)

Smart meter rollout	The Act on the Digitization of the Energy Transition (GDEW) stipulates installation of smart metering systems by 2032, if technically feasible and economically viable. In this law, the Metering Point Operation Act was introduced. The Metering Point Operation Act has been in force since 2016 and governs the installation and operations of smart meters. It creates a binding framework for the secure and data-protection compliant use of smart metering systems in different areas of application while also creating rules on financing of smart meters (BMWK 2024). Germany has been one of the laggards in smart meter adoption. However in 2023, the German Government revised the GDEW to accelerate the rollout of smart meters. Consumers of above 6,000 kWh per year and systems operators with an installed capacity above 7kW affected by this mandatory rollout (FfE 2023). A 95% uptake within the identified categories is targeted by 2030. Metering fees will be limited to 20 euros per year for consumers and small plant operators equipped with smart metering systems. Network operators will receive a greater share of the costs of metering point operation (FfE 2023). The main driver is the modernization of the measurement systems for nationwide smart-grid development. There are no mandatory or voluntary targets for the use of gas smart meters in Germany, which are a major energy source.
Data Protection	The Federal Office for Information Security (BSI) has created 10 privacy safeguards to ensure exceptionally high data protection and security standards apply throughout the development, manufacturing, distribution, and operation of smart meter gateways, including provisions such as: explicit approval by the consumer for data gathering; intervals of meter readings need to be long enough, to prevent user habit insights; transmitted data needs to be anonymized, pseudonymized, or aggregate; data is processed at consumer's premises and deleted in specified time period. Ultimately, smart metering data is subject to stringent data protection and security rules across Germany (BMWK 2015).
EPC	EPCs are mandatory in Germany when selling or renting out real estate, pursuant to the German Buildings Energy Act (Dena 2024).

Data collection	Metering data must be stored directly at the smart meter device. Up to 24 months of data can be downloaded at any time by the end user and shared with third parties. After the use of data, the supplier is obliged to delete all person-related metering data. There are currently no options to transfer metering data out of the meter electronically.
Energy performance modeling services	Generally, the accessibility limits to real-time data also limits the operation of energy performance modeling. To date, measurements can often only be conducted with intrusive technologies like Wi-Fi plugs or smart plugs. For smart meter measurements, an installation of a smart meter would be needed. Multiple Energy insights Apps are available for households like the EnergieCheck App (Verbraucherzentrale 2024), which is freely available to consumers and funded by the Government. Some companies like Techem offer individual household services like the "digitaler Heizungskeller" which aim to optimize the heating system (Techem 2024).

4.2.2 ASSESSMENT AND CONCLUSION

The factsheet for Germany indicates that the readiness and replication potential for the proposed collaborations in the near term are **low to medium** due to the following reasons:

- **Low smart meter penetration rates**: Germany has not yet achieved widespread deployment of smart meters. A low penetration rate limits the availability of real-time consumption data, which is crucial for creating detailed and accurate datasets. Furthermore, there are no active plans to make the rollout mandatory for consumers with consumption levels up to 6,000 kWh, which excludes the largest share of residential energy consumers. Similarly, there are no mandatory or voluntary targets for the use of gas smart meters in Germany, which are a major energy source.
- **Underdeveloped data management infrastructure**: The grid hub data management system in Germany is not yet fully optimized for widespread data sharing and integration between smart meters, utilities, and external market participants. The infrastructure needed for a seamless data exchange is underdeveloped, posing a challenge to the implementation of sophisticated data-driven projects.
- **High data protection provisions:** Germany has stringent data protection laws. These regulations impose strict controls on data collection, storage, and sharing. While these measures protect consumer privacy, they also hinder the ability to collect large-scale, non-intrusive insights from smart meter data, making comprehensive energy consumption analyses infeasible at this point.
- **Strong regulatory and policy framework**: With the revised Act on the Digitization of the Energy Transition (GDEW), Germany has a robust regulatory framework that supports the smart meter adoption. These policies will likely evolve to support greater data integration and utilization, making it easier to implement advanced energy management solutions.

Amongst the potential use cases for collaborations between FIs and energy data management service providers, use cases 2 and 3 can be implemented in Germany, when direct engagement with the FI's customers is possible and intrusive measurement devices are installed. This would enable FIs to offer tailored financial products and services. The lack of installed smart meters as well as high data protection provisions reduce the ability to non-intrusively receive insights on a large scale, making use case 1 feasible only if FIs are willing to take on an active role in preparing their buildings portfolio for such data analyses, e.g. by funding the installation of smart meters for their customers or facilitating access to aggregated data such as energy bills.

4.3 SPAIN

4.3.1 COUNTRY FACTSHEET

Spain

Share of households with smart electricity meters installed, % (FfE 2023)

100%

Near-term target

5.7 million analogue gas meters will be progressively replaced by smart gas meters by 2028

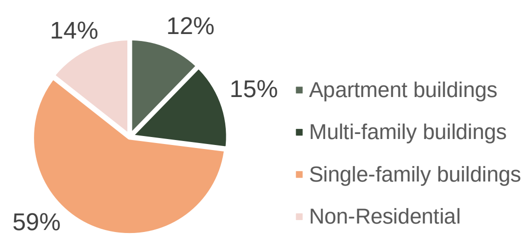


Figure 10: Building Stock, source: BSO (2024)

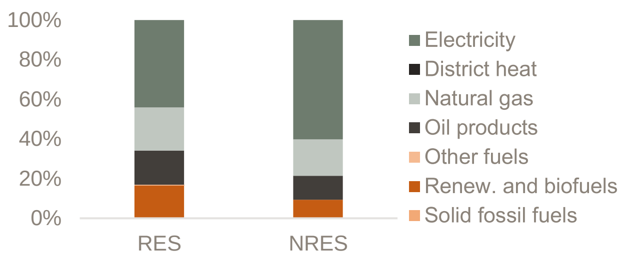


Figure 11: Share of fuels in final energy consumption of residential (RES) and non-residential (NRES) sector, source: Eurostat (2024)

Smart meter rollout	Spanish regulations – Real Decree to 216/2014 and Resolucion 6203/2015 – set the framework for how DSOs should provide consumption information to end users. Spanish law states that all electricity meter installations must have capabilities of remote management and time use functionality from 2007 onwards. By 2014, all utilities implemented Automated Meter Management (AMM) systems. By December 2018, all 27 million metering points contracting less than 15 kW of power were replaced by manufacturer-independent smart meters (Landys+Gyr 2020). The Spanish smart meter employed in Spain include many automated functionalities, which enable the creation of individual user consumption profiles. Through proactive support by national regulation, business models based on smart meter usage are favored (Lumenaza 2021).
Data Protection	Smart meters collect personal data relating to energy consumption meaning that it is subject to data protection regulations such as the Spanish Data Protection Act. The AEPD (Spanish Data Protection Agency) supervises the implementation of and compliance with the Spanish Data Protection Act by all data controllers and processors (OneTrust Data Guidance 2023).
EPC	According to the Royal Decree of 235/2013 from June 1, 2013, all owners planning to sell or rent property in good condition built in 2007 will need to have an energy certificate. Violators can be fined up to 300 to 6,000 euros (Vitro Property 2021).
Data collection	Metering data from smart meters is stored in the DSO's metering system. The DSOs provide a website that allows end users connected to its distribution network to download and view their hourly load profile once billed. The profiles are sent daily to traders and end users billed monthly in accordance with their consumption. DSOs send the data to traders through secure file transfer protocol (FTP).

	Traders can access their customers' data. Accessing non-customers' data is only possible with explicit consent (European Smart Grids Task Force 2016).
Energy performance modeling services	In 2020, Spanish distributors launched a platform called DATADIS through which electricity consumers in Spain will have a common interface to connect with all the distribution companies and view their electricity consumption data. The platform is a data gateway that accesses all the databases of Spanish distribution companies (EPD 2020). Startups are getting increasingly active in this ecosystem. For instance, Hobeen is a Spanish startup that has developed a virtual energy assistant that helps users optimally consume energy resources (BIC ARABA 2021). IES Energy Modeling Software is used to predict building energy consumption and is present in Spain. ESCAN Energy Consulting focuses their work on the overall definition of Smart Energy Performance Contracting Concept and is supporting Murcia and Rivas-vaciamadrid to improve energy efficiency.

4.3.2 ASSESSMENT AND CONCLUSION

The factsheet indicates that overall conditions in Spain for the proposed collaborations are **high**. The following overarching conclusions can be drawn:

- **High smart meter penetration rates:** Spain has achieved significant deployment of smart meters by 2018 enabling both small and large-scale data driven grid development and dynamic integration. Furthermore, the smart gas meter rollout is ongoing, with full penetration planned by 2028.
- **Decentralized environment for data storage:** In Spain, individual DSOs provide hourly load profiles and a website for end users to download hourly data. The decentralized environment of data storage in Spain has created an opportunity for organizations to retrieve data on a location specific basis and offer energy performance modeling services.
- **Favorable business opportunities for smart grid applications:** Spain actively supports the expansion of B2C and B2B business models for real-time energy data collection. This has enabled several start-ups and large-scale Energy-as-a-Service platform providers.
- **Individual consent required:** While the political environment in Spain supports the deployment of business opportunities related to non-intrusive energy measurement, data law provisions require individual consent by households for use by third parties.

For the implementation of use case 2 in Spain, several service providers could be considered. The capabilities of FIs to offer tailored financial products and services are under development. Therefore, use case 3 is expected to become feasible in the coming years. The availability of decentralized smart meter data collection as well as favorable regulatory conditions present a high potential for the implementation of use case 1, while ensuring consent from building owners and operators.

5. Recommendations

This analysis of the data supply chain identified potential use cases for FIs to collaborate with energy data management platform providers and assessed the boundary conditions for such collaborations in different European countries. The results highlight significant opportunities for FIs to enhance their carbon accounting capabilities, improve financial products, and support the transition to net-zero buildings. FIs and data platform service providers also need to consider local and technological boundary conditions which may impact the decision-making process and structure of these type of collaborations. The following is an overview of these findings and recommendations to FIs:

1. **Leverage B2B collaboration for multiple benefits:**
   - **Conclusion**: Collaborations with energy data management platform providers can enable FIs to retrieve contextualized energy data of their mortgages and commercial real estate portfolio. By using real-time and historical energy data, FIs can better predict energy consumption trends, track their emissions and support investments in energy-efficient technologies.
   - **Recommendation**: As FIs can benefit in multiple ways from collaborations with energy data management platform providers, FIs should be clear on the goal they want to achieve through such collaborations and should carefully consider suitability and capabilities of different energy data management platform providers during the decision-making process.

2. **Jointly ensure quality of the approach:**
   - **Conclusion**: A collaboration of FIs with energy data management platform providers may enable FIs to more accurately and precisely account for GHG emissions. However, models need to be thoroughly assessed and developed towards the level of data and model quality that is required.
   - **Recommendation**: Depending on the goal of the FI (e.g., improving the data quality of their mortgages and commercial real estate portfolio), the capabilities and quality of the methods used by service providers should be thoroughly scrutinized. Service providers can assist FIs in this process by providing necessary insights into their modeling process, uncertainty and quality management approach. Additionally, FIs and service providers should closely align and co-create the suitable approach for their needs.

3. **Consider the boundary conditions of the local data supply chain:**
   - **Conclusion:** Location specific boundary conditions on data infrastructure may require different types of engagement.
   - **Recommendation:** FIs should consider potential use cases from a location specific context. For instance, while some countries like Spain offer a decentralized access to data, others like Germany prevent access to individual devices. This may require different approaches in each target country. Service providers can play an important role by educating FIs about these potential differences and offer tailored solutions.

4. **Foster customer engagement to enhance financial products and services:**

- **Conclusion**: Detailed energy consumption insights enable FIs to develop tailored financial products that promote energy efficiency and sustainability.
- **Recommendation**: With the help of energy data management platform providers, FIs can develop a holistic user journey to educate customers about green financial and non-financial products, and offer them approaches specific to their individual building improvements, for instance through loans for solar panel installations, insulation or electric vehicle purchases. Additionally, customized mortgages for energy-efficient homes and insurance products with premiums based on stable energy usage patterns could be introduced.

5. Leverage public-private partnership for sustainability projects

- **Conclusion**: Alignment of green financial and non-financial products with existing public subsidy schemes supports the leverage for smart meter data for energy efficiency and sustainability.
- **Recommendation**: FIs should actively seek out national and European funding programs that support the development of green financial products and data-driven energy strategies. Furthermore, FIs should inform their customers on potential funding opportunities for the implementation of energy efficiency measures.

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