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Active managed Buildings with
Energy performaNce Contracting

Deliverable Number (D7.4)

Data Management Plan

The AmBIENCe consortium

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EXECUTIVE SUMMARY

Deliverable 7.4 “Data Management Plan” describes how the data collected from the pilots will be used or shared/made accessible for the verification and re-use and how this data will be curated and preserved.

Chapter 2 describes the data collected in the Belgian pilot, this encompasses the data collected for the static simulations, dynamic simulations and the financial and economic analysis that were used in the contracting phase to develop the Active Building Energy Performance Contract (AEPC). The results obtained with the Active Building Energy Performance Modelling (ABEPeM) platform for the contracting phase were described as well in this chapter.

The data collected in the Portuguese pilot are described in **Chapter 3**. This includes the data needed for the dynamic simulations and the financial and economic analysis with the ABEPeM platform. In contrary to the Belgian pilot no results were obtained yet with the ABEPeM platform for the Portuguese pilot, as the input data were only available end of February 2022. Therefore, these data are not described in this deliverable.

Data sharing, data access and preservation of data is presented in **Chapter 4.** Data sharing and data access is different for the two pilots and related to the different views of the responsible organisations for the two pilots. Data preservation was done in a similar way for the two pilots and is described in this chapter as well.

The data security and ethics are described in **Chapter 5**, followed by some conclusions presented in **Chapter 6.**

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1. INTRODUCTION

Deliverable D7.4 "Data Management Plan" describes the handling of the data collected in the two AmBIENCe pilots, and describes the use and/or sharing of these data to allow verification as well as the preservation of the data.

1.1 BACKGROND AND CONTEXT

The AmBIENCe project has provided the new concept of Active Building Energy Performance Contract (AEPC) (1) which is an enhanced form of a classic Energy Performance Contract (EPC) with a focus on electrification and flexible resources using the Demand Response (DR) programs within the EPC contract. Moreover, a proof-of-concept platform, called the Active Building Energy Performance Modelling (ABEPeM) platform (2) is developed to support Energy Service Companies (ESCOs) in the design of AEPC contracts, calculating the performance baseline, project Key Performance Indicators (KPIs) and guarantees, as well as the flexibility options and added revenue streams resulting from DR activities. A variety of business models are introduced to support engaging the stakeholders in the AEPC contract (3). One of the missions of the AmBIENCe project was to provide the new AEPC concept in a way that applies to a wider scope of building types, as well as to a cluster of buildings supporting the trending approaches (4).

To verify the effectiveness of the proposed concept and business models, the AEPC concept, methodology, and business model are being tested with two demonstration cases: an office building in Portugal and a residential building in Belgium.

1.2 PURPOSE AND SCOPE OF THE DOCUMENT

The AmBIENCe project has collected or generated data in the framework of the pilots. More specifically, all data to prepare the AEPC contract were collected and generated, as well as the first preliminary data to prepare the operational phase.

This document, Deliverable D7.4 "Data Management Plan", describes the handling of the data collected in the two AmBIENCe pilots, both the Belgian pilot and the Portuguese pilot. It describes the use and/or sharing of the data to allow verification as well as the curation and preservation of the data. It is inspired by the concept of FAIR data principles, i.e. research data that are findable, accessible, interoperable and re-usable.

2. DATA COLLECTION IN THE BELGIAN PILOT

2.1 DESCRIPTION OF THE PILOT [1]

The building is a privately owned residential building located in the small town of Seneffe, about 50 km south of Brussels. It is occupied by the couple who bought the house in October 2012. The house was built in 1912 and is a typical example of a "Maison de maître" (urban mansion). As a consequence, there are some major constraints on insulation from the outside for aesthetic reasons, but also because of urban regulations.

It has a main volume consisting of a ground floor (hall & staircase, living room and dining room), a first floor with a large space to hold artistic workshops and a second floor that currently serves as an attic. There is a smaller volume to the right (currently unoccupied on the ground floor and a storage room for the artistic workshop on the first floor) and an extension to the back (private office space and small TV space, kitchen and washing room on the ground floor, as well as a bathroom and bedroom on the first floor). There is also a double garage at the back. On the right side, there are two rooms and a small entrance hall, that act today as storage and guest bedroom.

Figure 1 shows some pictures of the volumes and a graphical representation of the global volume of the building.

FIGURE 1 - OVERVIEW AND GRAPHICAL REPRESENTATION OF THE BUILDING (5)

Most roofs are traditionally sloped and not insulated, except for a flat roof above the bathroom and bedroom in the back volume. The flat roof has been renovated and insulated in 2020. All walls are in bricks and are not insulated. Most windows are in Polyvinyl Chloride with double glazing (from the first generation). The doors and windows of the office space and kitchen (main heated volume), have been replaced in 2013 with double highly insulated glazing in the existing wooden frames. There are two wooden frames left with single glazing in the storage room of the artistic workshop on the first floor.

The building is heated with a wood pellet stove and a condensing gas boiler (the latter replaces a fuel-fired boiler since 2016). One of the building's particularities is the fact that it is being used in a very modular way.

[1] Description adjusted from (5)

In winter, only the private office space/TV space, the kitchen, the bathroom and the bedroom next to it, are continuously heated. All other spaces are only heated occasionally (e.g., living and dining room at the front), for a few hours a week (e.g., artistic workshop) or not at all (e.g., storage and guest bedroom on the ground floor, second floor). The office space and kitchen are being used all year long because of the owners' professional teleworking profile.

There is no specific maintenance contract, but basic legal 2-yearly gas boiler maintenance, yearly wood pellet stove maintenance and 2-yearly chimney cleaning is done. The EPC will include a number of Energy Efficiency (EE) and renewable energy (RE) measures among which building envelope insulation, photovoltaic cells (PV), heat pump, Electrical Vehicle (EV) charging and smart control. The purpose is to extend this EPC to become an initial Active building EPC, by adding and exploiting electrification of heat supply (i.e., via a heat pump) with the PV and EV charging, as well as other appliances, allowing for flexibility.

2.2 DATA COLLECTED IN THE PILOT

2.2.1 GENERAL INFORMATION

The following data were assembled by the building owner and were used in the pre-contractual phase of the Belgian pilot:

- General information on the heating system;
- Electricity consumption data from 2012 to 2020 (monthly, kWh and cost);
- Fuel consumption data from 2012 to 2016 (when the fuel boiler was replaced by a condensing gas boiler) (fill-up, litres, MWh and cost);
- Gas consumption data from 2016 (when the gas boiler was installed) to 2020;
- Wood pellet consumption from 2013 to 2021 (kg, kWh and cost);
- Water consumption from 2012 to 2021 (not yet consolidated);
- Annual Degree days from 2012 to 2020;
- Inventory per room - Dimensions, typical heating times, type of window/glazing, type of radiator, heating source, typical comfort requirements per room;
- List of electrical appliances and equipment - Type, Power and usage.

A ground plan of the building is available detailing the subdivision of the building in different rooms with their surface and volume.

An energy scan, realized by a local energy consultant as part of a municipal energy accompaniment plan, as well as an energy audit, realized by a certified energy auditor, were also made available. The audit covered both insulation measures, PV and heating system upgrades. The limitation of the energy audit is that it uses theoretical consumptions, based on theoretic standard comfort requirements. Because the building is used very modularly and certain rooms, like the artistic workshop spaces, are only heated at specific moments of the week and not during school holidays, the practical usability of the energy audit is rather limited. The energy scan is in any case very generic and of limited added value compared to the more advanced static and dynamic simulations performed in AmBIENCe as part of the pilot.

There was no EPC implemented, but the owner wanted to investigate the possibility to implement an EPC and include a number of EE and RE measures: thermal insulation, PV, heat pump, Electrical Vehicle charging and smart control. The purpose is to extend this EPC to become an initial Active building EPC, by adding and exploiting electrification of heat supply (i.e., via a heat pump) with the PV and EV charging, as well as other appliances, allowing for flexibility.

During the pre-contractual phase the design exercise was done in two steps:

1. First, a static design and simulation was undertaken, allowing to identify the major energy efficiency measures (EEMs) (insulation of roofs, walls and floors, replacement of windows, solar PV panels, heat pump) and calculate the estimated savings. This allowed us to determine the Thermal Conductivity (K-value) after the planned works and the necessary heat pump power.
2. A dynamic simulation taking into account these energy measures, but in addition to that the flexibility potential of the building to implement flexible EEM. The dynamic simulation has been performed with the ABEPeM tool.

The business case was calculated with the economic and financial calculation module of the ABEPeM platform.

2.2.2 DATA FOR THE STATIC SIMULATIONS

The following data were collected in order to perform the static simulations:

- The Thermal Transmittance (U-value) for all surfaces (roof, walls, windows, doors and floor) of the house;
- The Thermal Resistance (R-value) for all surfaces (roof, walls, windows, doors and floor) of the house.

The following data were generated in the static simulations:

- The U-value for all surfaces (roof, walls, windows, doors and floor) of the house for the scenario after renovation;
- The R-value for all surfaces (roof, walls, windows, doors and floor) of the house for the scenario after renovation;
- Energy demand and K-value were calculated for the current situation and after renovation;
- The requirements for the heat pump: an air-water heat pump of 22 kW;
- An optimized PV installation of 10.725 kWp composed of 220 slates and 20 panels;
- Planned car battery capacity of 74 kWh.

2.2.3 DATA FOR THE DYNAMIC SIMULATIONS USING THE ABEPEM PLATFORM

The ABEPeM Flex Model Creation module was used to achieve a simplified dynamic thermal model of the building. Since there was no permanent monitoring equipment present in the building, a temporary monitoring system was put in place. The heating system was monitored for 4.5 weeks from April 22, 2021, to May 25, 2021, and the following data were collected:

- Thermal power: Due to the small scale of the building and accessibility of the main heating collector pipes, it was possible to perform a direct measurement of the thermal output power of the gas boiler;
- Internal temperature: Temporary temperature sensors were placed at four strategic points in the building: living room, kitchen, bathroom and space to hold artistic workshops;
- Solar radiation and external temperature: Publicly available high-resolution data has been used for this purpose (6) (7).

To build the thermal model assumptions were made on:

- The temperature range allowing the requested comfort level;
- The electricity tariff structure;
- And the EV Charging Profile.

2.2.4 DATA FOR THE FINANCIAL AND ECONOMICAL ANALYSIS USING THE ABEPEM PLATFORM

The following data was provided as input for the financial and economic module of the ABEPeM platform:

- Project details;
- Project general parameters;
- Assets general details,
- Operating expenses,
- Investment details,
- Financing details,
- Yearly Energy Consumption,
- Energy and costs savings performance between different scenario's.

2.2.5 RESULTS FROM THE ABEPEM PLATFORM

For the calculations in ABEPeM, eight different cases were simulated:

- Case 1: Reference case;
- Case 2: Building after renovation;
- Case 3: Introduction of the heat pump instead of the gas boiler and wood pellet stove;
- Case 4: Installation of PV panels;
- Case 5: Introduction of EV charging;

- Case 6: Simulations with smart heating;
- Case 7: Simulations with smart charging;
- Case 8: Simulations with smart heating and smart charging combined.

For each of these eight cases, the following data were simulated:

- Total energy cost;
- EV charge back costs (for case 5-8);
- Effective energy cost;
- Consumption of uncontrollable load + EV charging + heat pump (in kWh);
- Electricity offtake (in kWh);
- PV production (in kWh, for case 4-8);
- Electricity injection (in kWh, for case 4-8);
- Gas consumption (in kWh, for case 1-2).

Four different business case scenarios were looked at, corresponding to Cases 5, 6, 7 and 8. The business case is looked from the point of view of the (residential) business owner. The following data were calculated:

- Total investment;
- Average energy savings (in euro and kWh);
- Net present value;
- Total cost of ownership;
- Payback time.

3. DATA COLLECTION IN THE PORTUGUESE PILOT

3.1 DESCRIPTION OF THE PILOT[2]

The pilot site is a services building located in the centre of Oporto at an altitude of 86 meters and less than 5 kilometres from the maritime coast. The building complex, composed of two buildings, designated by building A and building B, was inaugurated in 2011 and is one of the two EDP national headquarters, as depicted in Figure 2. For the Portuguese pilot, we will focus our attention on building A due to the availability of monitoring equipment. Furthermore, the COVID-19 pandemic situation significantly reduced the occupancy of building B, resulting in reduced energy needs. Building A has a useful floor area of 18,655 m^2 and normal utilization of around 600 people. It is composed of ten floors of which three are underground floors dedicated to parking and technical areas, with 7 EV chargers installed for use by employees, with 8 more planned to be installed. There is a partially automated control of the building's consuming devices, including lighting and Heating, Ventilation and Air-Conditioning (HVAC), although the overall level of smartness of the building can be considered low.

FIGURE 2 - EDP PORTO BUILDING COMPLEX. BUILDING A (LEFT), BUILDING B (RIGHT).

The facades of the building are covered with power-driven shading blades. On floor -1, there is a laboratory, a printing room, a meeting room, sanitary installations and an auditorium. On floor 0, the EDP store, medical rooms, the reception, meeting rooms and a cafeteria are located. The upper floors are constituted by office rooms, mainly open space, sanitary installations, small kitchens and meeting rooms. Each office floor has a contained "data centre" room, where varying dimensions of server racks are housed. These are climatised by a separate cooling system due to the criticality of the components – a Daikin Split Closed Control system, located on floor –1, which ensures temperature control across the data centre rooms on each floor. Separate from this purpose, the building has 10,820 m^2 of climatised area, mainly office space, with the remaining areas not climatised, such as garage floors, corresponding to 7,865 m^2. In the climatised

[2] Description adjusted from (5)

areas, the average height of the rooms is 3.1 m. The construction solutions provide the building with medium-grade thermal inertia.

PV was available with an installed capacity of 42,24 kWp and an estimated production of 54,8 MWh/year.

3.2 DATA COLLECTED IN THE PILOT

3.2.1 GENERAL INFORMATION

The following data was gathered by the pilot owner and used in the pre-contractual phase of the Portuguese pilot:

- General information on the heating system;
- General information on the cooling system;
- Overview of the EEM already existing in the building;
- Total energy consumption of the building A;
- Energy consumption in the exhibition room (Fundação EDP);
- Energy consumption in the garage floors;
- Energy consumption in EDP retail store;
- Energy consumption in another retail store;
- Energy consumption in the gym;
- Energy consumption in each of the office floors (6 office floors per building);
- Energy consumption from HVAC in the building;
- Energy generation from PV;
- A set of EEM proposed in an Energy audit (2017).

There was no EPC implemented, a Building Energy Management System (BEMS) was existing but will be replaced in 2022. The building owner was interested to integrate smart HVAC solutions in the building, that can be monitored and aligned with the new to-be-installed BEMS. The Portuguese stakeholders decided therefore to check for the possibilities of smart heating and cooling as the flexibility measures in the Portuguese pilot.

3.2.2 DATA FOR THE DYNAMIC SIMULATIONS USING THE ABEPEM PLATFORM

Weather data and inside temperature data are essential for the modelling of the building and the consequent development of the AEPC. This information was not available at the start of the project. Therefore, weather data, such as solar radiation and external temperatures, was collected online as an alternative (6) (7) and 42 temperature sensors were installed across five office floors to collect inside temperatures on a minute by minute basis from April 1, 2021 and for the duration of the project. The sensors were installed with the following disposition per floor as illustrated in Figure 3 for the first floor, and are depicted in the white boxes with the numbers. The first number represents the floor number, while the second number represents the number of the sensor on that floor.

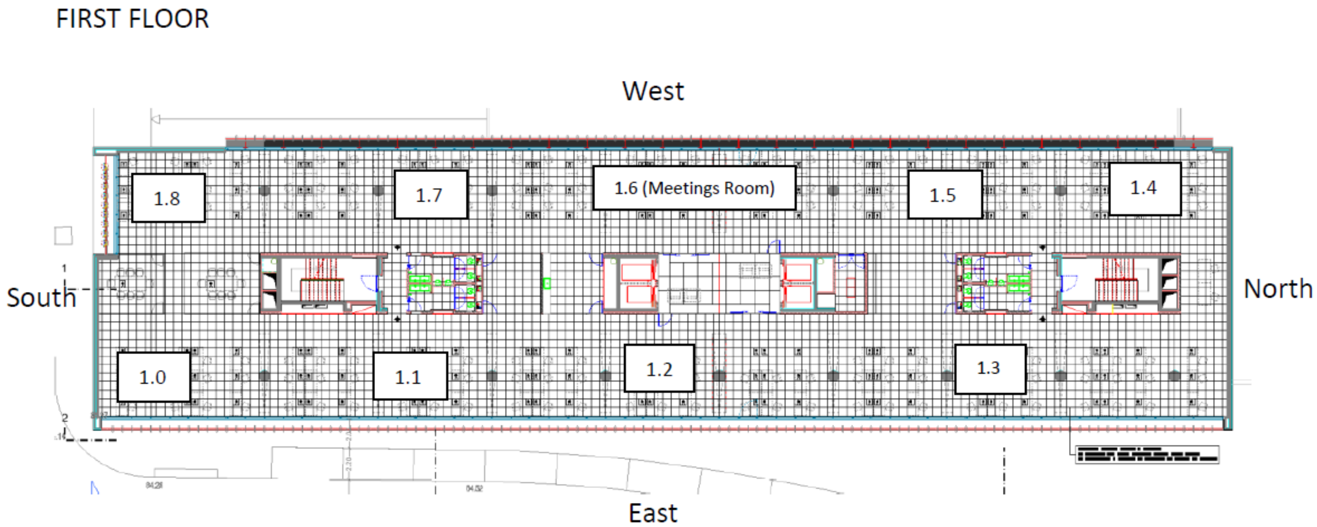

FIGURE 3 - DISPOSITION OF THE SENSORS. EXAMPLE FOR THE FIRST FLOOR.

Overall consumption data for the building and data for the overall consumption of the HVAC system, with 15-minute granularity, was collected from April 1, 2021 and for the duration of the project. However, after attempts to develop the thermal building of the model, it was realised that the disaggregated consumption for heating and cooling is required to model how the comfort levels can be maintained while shifting the operation of the HVAC. Therefore, additional monitoring equipment was installed in the building to collect more granular data than is already available. This equipment includes 12 current transformers, 4 energy analysers, a data concentrator and a router, to collect consumption data directly from the 3 chillers and the heat pump. This monitoring data, with 15-minute granularity, was available from February 4, 2022 and for the duration of the project.

3.2.3 DATA FOR THE FINANCIAL AND ECONOMICAL ANALYSIS USING THE ABEPEM PLATFORM

The following data will be used as input for the financial and economic module of the ABEPeM platform:

- Project details;
- Project general parameters;
- Assets general details;
- Operating expenses;
- Investment details;
- Financing details.

3.2.4 RESULTS FROM THE ABEPEM PLATFORM

The data from the measurements of the disaggregated heating and cooling only were available by the end of February 2022, therefore the simulations with the ABEPeM platform were still ongoing when submitting this deliverable. Therefore, these data were not included.

4. DATA SHARING, ACCESS AND PRESERVATION

Where possible, AmBIENCe aims to handle the data from the pilot in a FAIR way, which means they are findable, accessible, interoperable, and re-usable, however also taking into account possible privacy issues.

As described above in Chapter 2 and 3 the following data were collected or simulated with regard to the pilots:

- General information: data on the heating and cooling system, energy consumption data, EEM applied, ... ;
- Data needed for the static simulation: this simulation was only done for the Belgian pilot and includes information on insulation (U-value, R-Value, K-value), an optimized PV installation, requirements for the heat pump and a planned car battery capacity;
- Data needed for the dynamic simulations using ABEPeM: besides publicly available sources for solar radiation and outside temperature also on-site measurements with installed sensors are used. Data are needed as 15-minute resolution data;
- Data for the financial and economic analysis using the ABEPeM platform;
- Results from the ABEPeM platform (available for the Belgian pilot only).

4.1 DATA SHARING

All data collected in the pilots can be shared with interested parties, although the level of sharing highly depends on the nature of the data, the origin of the data (private vs public data), the data utility (how useful might the data be), ...

For the Belgian pilot, the pilot owner agreed to share all the data linked to energy (consumption, cost, assumptions made, ...) publicly, while the financial data can be made available on request. For the Portuguese pilot data will be shared only upon specific request.

Within the AmBIENCe project there are three public deliverables where data available in the pilots are mentioned or described:

- Deliverable D7.4: Data Management Plan;
- Deliverable D3.4: Report on the preparation of the operational AEPC in pilots;
- Deliverable D3.5: Pilot Evaluation report of the proposed Active Building Energy Performance Contract concept and business model.

The latter two deliverables are being produced and will soon be available.

Data on the pilots have also been presented at different occasions in various events, allowing interested parties to be informed about the data gathering.

Most data in the pilots are available as text format or as csv-file. This highly facilitates the sharing of data as no methods or software tools are needed to access the data. This implies that the data collected and produced in the pilots are usable by third parties, also after the end of the project as the data remains re-usable for other purposes.

Data that were publicly available such as solar radiation and external temperatures are referred to by providing the reference (6) (7).

4.2 DATA ACCESS

The publicly available data are described in the public deliverables described higher.

For the Belgian pilot, the pilot owner agreed to share all the data linked to energy (consumption, cost, assumptions made, ...) publicly on the AmBIENCe website (8) as long as this is online; and afterwards on the website of ENERGINVEST (9). The financial data can be made available upon request at Lieven Vanstraelen, Owner and Senior Partner of ENERGINVEST, Mobile +32 495 551 559, lvanstraelen@energinvest.be.

With regard to the Portuguese pilot the data produced and/or used in the project will be kept closed as the default. However, data can be made accessible upon request at Claire Harvey, Mobile: +351 915 296 643, Claire.Harvey@edp.pt.

Most data in the pilots are available as text format or as csv-file requiring no methods or specialised software tools to access the data.

4.3 DATA PRESERVATION

All input data assembled in the pre-contracting phase of the pilots were deposited on the AmBIENCe sharepoint that is only accessible by the project partners that have been specifically provided access to. Confidential data were marked by the person adding the data to the sharepoint. During the lifespan of the project the AmBIENCe sharepoint remains available, after the project end the data on the sharepoint will be stored at the respective pilot owners (each for their own pilot).

The Python code that was generated for the dynamic simulations will be stored at VITO, and be classified as confidential information.

The information from the Belgian pilot that will be made publicly available is stored on the AmBIENCe website (8) as long as this is online; and afterwards on the website of ENERGINVEST (9).

5. DATA SECURITY AND ETHICS

The data collected in the pilots are required to perform the simulations with the ABEPeM platform and/or are needed to prepare the AEPC contract or business case for the pilots. Data not required for research purposes were not collected.

The Portuguese pilot is an office building and the AmBIENCe consortium has not collected data affected by privacy rules.

The Belgian pilot is a residential building owned by a single couple, therefore it is hard to anonymise the data. There is a potential ethical risk in terms of data collected susceptible to represent personal data, energy consumption patterns present a potential ethical risk, as they may represent personal behaviour habits or lifestyle and personal schedule. However, sensitive personal data (e.g. health, sexual lifestyle, and ethnicity, and political opinion, religious or philosophical conviction) cannot be obtained from energy consumption data. The house is owned by one of the partners of ENERGINVEST, that is partner in the project. Moreover, the owner of the house selected the data he provided to the consortium and explicitly gave permission in an informed consent to share these data between the relevant consortium members, and to place a selection of the data on the publicly available AmBIENCe website (8).

In the two pilot cases, the consortium informed the building users about the data collection and usage, and the organisations in charge of it. The AmBIENCe consortium worked in accordance with the national data protection laws of Portugal and Belgium.

6. CONCLUSIONS

Deliverable 7.4 “Data Management Plan” describes how the data collected from the pilots will be used, shared, made accessible for the verification and re-use and how this data will be preserved.

After a description of each pilot, all input data used to design the AEPC contract through the ABEPeM platform were presented. For the Belgian pilot all the simulations performed with ABEPeM were finalized and mentioned as well, for the Portuguese pilot the simulations in ABEPeM were still ongoing during the preparation of this work.

For the Belgian pilot, some data are accessible on a publicly available website (AmBIENCe (8) or ENERGINVEST (9)), the other data are available upon request at the pilot owner. With regard to the Portuguese pilot, the data produced and/or used in the project will be kept closed as the default. However, data can be made accessible upon request by interested parties.

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ABBREVIATIONS AND ACCRONYMS

ABEPeM	Active Building Energy Performance Modelling
AEPC	Active Building Energy Performance Contract
BEMS	Building Energy Management System
DR	Demand Response
EE	Energy Efficiency
EEM	Energy Efficiency Measures
EPC	Energy Performance Contract
ESCO	Energy Service Companies
EV	Electrical Vehicle
HVAC	Heating, Ventilation and Air-Conditioning
KPI	Key Performance Indicators
K-value	Thermal Conductivity
PV	photovoltaic cells
RE	Renewable Energy
R-value	Thermal Resistance
U-value	Thermal Transmittance