
# D3.4.2

# WP3 - WG2 Information System

# Pilot Activity Final Report

## Final version

**SHERPA**

SHared knowledge for Energy Renovation in buildings by Public Administrations.

Priority axis-Investment Priority-Specific Objective 2-1-1

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# Content

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## 1. Introduction

The principal objective of SHERPA is the implementation and testing of a holistic, transnational and peer-to-peer approach for developing of effective strategies for Energy Efficiency of Buildings (EEB) based on coordinated actions in the four key areas: Governance, Information, Training and Financing. The specific activities in each of these areas are organised in separate Work Groups (WGs), with the overall objective to test the model using a sample of 1000 public buildings belonging to regional or local governments across the 8 SHERPA partner regions. Among these buildings 100 public regional buildings will have finalised Efficient Energy Building (EEB) projects with proposal financing operative schemes at the end of SHERPA duration.

The WG2-Information System is providing the Information and Communication Technologies (ICT) infrastructure of SHERPA and is responsible for the collection of building information and data, and development of the methodologies for analysis in order to support the strategic operative and policy decisions of SHERPA.

This document reports on the SHERPA's testing activities carried out within the WG2-Information System. The report includes an overview of the specific objectives and the methodology of work, and provides description of the activities and the achieved results. Finally, conclusions and recommendations are presented.

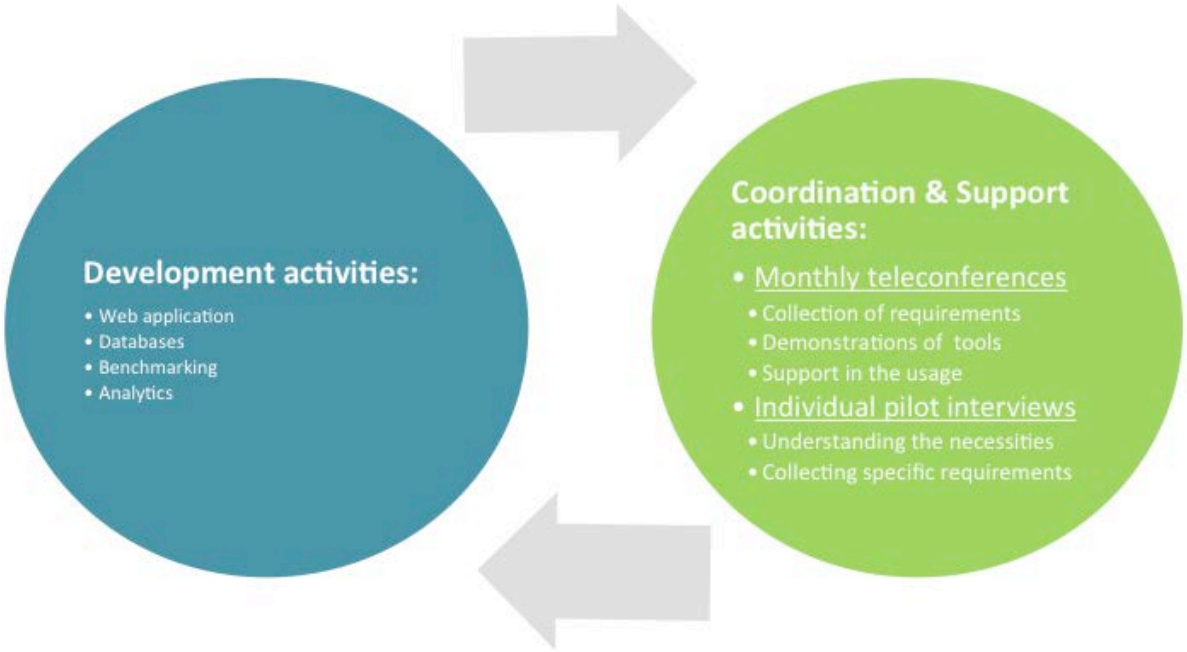


*Figure 1. Scope of Work Group 2 activities*

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## 2. Specific objectives of WG2

Work Group 2 (WG2) has the objective to provide the common Information System for collection and analysis of building data from the participating public administration partners during the testing period and from the municipalities joining the project during the Capitalisation phase.

The data collection is a key element for the implementation in practice of the peer-to-peer approach, as it allows identifying the scope of the possible improvements and making initial estimation of the necessary investments and assessment of their effect under real operating conditions. This information is essential for the effective EEB policy development and taking of strategic decisions of the public administrations at regional level and in capitalisation module at municipal level.

The SHERPA Information System brings together energy consumption data and information about Energy Efficiency Measures (EEM) being implemented in public buildings to treat these data using Big Data Analysis techniques. This data-driven analytic approach aims to overcome the disadvantages of simulation-based approaches that have shown considerable gap between predicted and real building performance. Unlike simulation, SHERPA approaches the analysis of the diverse building stock from the perspective of real building performance and reveals the most cost-effective measures to apply to different building typologies, as proved in real life operation.

In order to fully exploit the advantages of this approach, WG2 has set some specific objectives for the SHERPA Information System in the testing period:

- Implement and test various data collection methods to match the requirements of the different pilot sites
- Transfer of progressively larger batches of building data
- Collect data from approximately 1000 buildings
- Explore the data, detect and complete any existing gaps
- Design and implement appropriate analytics and produce useful outputs
- Analyse the results together with the pilots' feedback and implement gradual improvements of the Information System
- Produce conclusions and recommendations for further steps

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# 3. Methodology

This section describes the participants and their role in the WG2, and outlines the adopted methodology for organisation, coordination and performance of the work.

## 3.1. Structure of WG2

The WG2-Information System is led by CIMNE and participated by the 8 public administrations providing the SHERPA pilots, two technical supporting partners (IVE and CRES) and a communication supporting partner (CPMR).

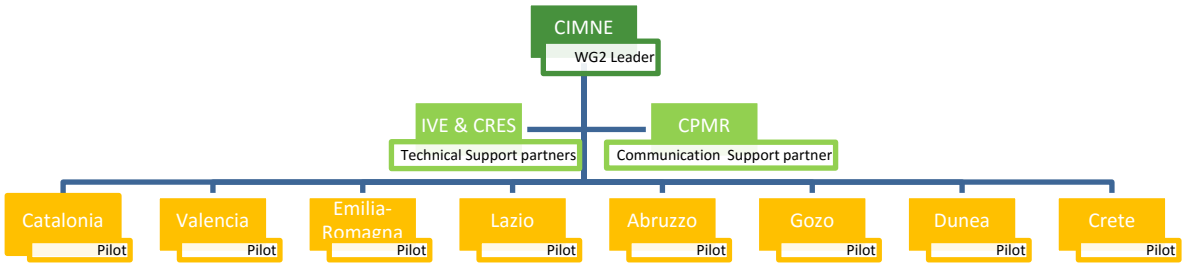


*Figure 2. Structure of Work Group 2*

The group leader CIMNE is the provider of the Information System infrastructure and has been responsible for the coordination of the work.

IVE has been providing technical and methodological support to the pilots and the WG leader and has been the responsible partner for the Valencia pilot.

CRES has been providing technical and methodological support to the pilots and the WG leader and has been the responsible partner for the Crete pilot.

CPMR has been responsible for enhancing the communication with the other work groups and for the dissemination and communication of the results.

The pilot responsible partners have been responsible for collecting and introducing the building and energy consumption data into the Information System, for testing its functionalities and for providing feedback and suggestions for improvement to CIMNE and the technical support partners.

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## 3.2. Methodology of work

The activities of the WG2 during the testing period followed a roadmap set up by the work group leader. The work started with the establishment of a WG2 Steering Committee represented by one member from each organisation responsible for each pilot and for liaising of the activities with the other work groups. The members of the Steering Committee are presented in Table 1.

The methodology of work comprised a number of activities aiming to set the specific objectives for each stage, to ensure the common understanding, the coordination and the progress towards the final objectives.

- Individual teleconference meetings between the WG2 leader and the pilot teams with the purpose to:
  - Understand the local organisation structure, get to know the local team and the responsibilities each member has in the organisation.
  - Identify particular pilot requirements and needs for data analysis
  - Identify the availability of data and the technical possibilities for bringing it to the SHERPA Information System
- Monthly teleconference meetings for all participants in the group to coordinate and follow up the progress of work.
  - Control the progress of work in each pilot
  - Analyse the problems and set operative targets
  - Clear doubts in using the Information System
  - Report new developments
- Face-to faces meetings during the Project Steering Committee meetings.
  - Coordination with the other work groups
  - Strategic objectives fulfilment analysis and planning
  - Control of work progress
- Online demonstrations of using the Information System
  - Interactive demonstration of the Information System features
  - Training, Questions & Answers
- Personalised support to pilots by email
  - Answering of specific questions and solving of problems

The follow-up the work progress in the pilots (introduction of building data and energy consumption) has been supported by an Excel-based management tool created for that purpose.

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*Table 1. Members of the WG2 Steering Committee*

| Partner organisation | Partner role* | Name | Email |
|---|---|---|---|
| CIMNE | WG leader & Tech | Stoyan Danov | sdanov@cimne.upc.edu |
| DGPAH | Pilot | Juan Antonio Bas | jbas@gencat.cat |
| EMILIA-ROMAGNA | Pilot | Claudia Mazzoli | claudia.mazzoli@regione.emilia-romagna |
| LAZIO | Pilot | Leonilde Tocchi | ltocchi@regione.lazio.it |
| ABRUZZO | Pilot | Laura Rosella | Laura.rosella@regione.abruzzo.it |
| GOZO | Pilot | Joseph Cutajar | joseph.g.cutajar@gov.mt |
| DUNEA | Pilot | Zvonko Čuljat | zculjat@dunea.hr |
| CRETE | Pilot | Maria Apostolaki | maria.apostolaki@gmail.com |
| IVE | Pilot&Tech | Vera Valero | vvalero@five.es |
| CRES | Tech | Eleni Chatzigeorgiou | echatzi@cres.gr |
| CRPM | Comm. | Emmanuel Maniscalco | emmanuel.maniscalco@crpm.org |

## 4. Work developed along the period

The work in WG2 during the testing period comprises a variety of activities. The activities started with setting up the overall organisation and organising introductory and online demonstrating sessions. Then the work continued with acquisition and introduction of data, gathering of requirements and use of the web application tool by the pilots, providing feedback, and further development and adapting of the Information System software.


*Figure 3. Activities in Work Group 2 during the testing period*

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## 4.1. Coordination and Support activities

In the period of Information System testing WG2 had 9 plenary teleconference meetings, 2 face-to-face meetings and 9 individual teleconference meetings with the pilot teams and AMORCE. In addition to these meetings, continuous support and feedback from the pilots have been ensured through email communications.

## 4.2. Software development activities

The Information System development in SHERPA started on the base of existing Big Data analytics infrastructure at CIMNE and has been adapted to the needs and requirements of SHERPA which have been defined and tested in WG2. The development during that period comprises numerous advances and new features included. The main lines of development are summarised here and more specific details are provided in the deliverable D3.4.1 Operative Database. The improvements of the functionalities resulting from the Testing at the pilots within WG2 are reflected among the results in the next section “Results”.

The development over the Big Data ICT infrastructure of CIMNE and its adaptation to the needs of SHERPA include the following:

- Development and adaptation of the SHERPA’s operational database
- Development of the SHERPA’s web application for user interaction with the Information System
- Development of Backend user administration methods and interfaces
- Development of Application Programming Interfaces (API) for communication between the web application, the Big Data databases and with external Energy Management Systems and Weather data providers
- Development and adaptation of analytic modules for treating the building data and producing results for the pilots
- Elaboration of technical documentation including online resources for the software developers in Github and user manual explaining the use of the system for the users from the public administrations.

## 4.3. Results

The work for testing in WG2 started over the initial version of the Information System provided by CIMNE and significantly improved it by enabling functionalities that potentiate its capabilities to support decision making and strategic planning for building renovation in the public administrations. The achieved improvements have been fruit of the gathering of considerable amount of building data and by testing in use of the Information System by the SHERPA pilots, thus refining the requirements and providing valuable feedback for the further development to CIMNE. As a result, the Information System has been prepared for the extended use during the Capitalisation phase of the project by a larger number of municipalities.

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During the testing periods the SHERPA partners have introduced 1013 buildings within the Information System, the major share of which corresponds to the Lead Partner DGPAH (Catalonia) and IVE (Valencia). The buildings introduced in the system include the 100 buildings selected for preparing of projects with proposal financing operative schemes, and the rest of buildings have been introduced to ensure the bulk of buildings necessary to enable the data-driven approach of SHERPA.

*Table 2. Buildings initially assigned to each pilot for Testing*

| Pilot name / Partner | Number of buildings introduced |
|---|---|
| **Catalonia / DGPAH** | 34 |
| **Valencia / IVE** | 14 |
| **Emilia Romagna** | 12 |
| **Lazio** | 3 |
| **Abruzzo** | 11 |
| **Gozo** | 10 |
| **Dunea** | 6 |
| **Crete / CRES** | 10 |
| **Total** | **100** |

The number of buildings introduced by each partner in the Information System is presented in Table 3.

*Table 3. Buildings introduced in the Information System for Testing*

| Pilot name / Partner | Number of buildings introduced |
|---|---|
| **Catalonia / DGPAH** | 744 |
| **Valencia / IVE** | 303 |
| **Emilia Romagna** | 12 |
| **Lazio** | 16 |
| **Abruzzo** | 11 |
| **Gozo** | 10 |
| **Dunea** | 6 |
| **Crete / CRES** | 11 |
| **Total** | **1.113** |

The introduced building data permitted the testing of the Information System's functionalities at each of the pilots and provided useful feedback for improvement.

The pilot feedback is summarised below and includes the main problems discovered in the process of testing and reflect the pilot requirements as well as the implemented solutions by CIMNE.

1) Data uploading to the Information System should be made easier for the users

Implemented solutions: Automatic procedures based on API for three different data providers in Spain (SIE, Dexma, Gemweb) have been implemented permitting the automatic upload of energy consumption and building information from other existing energy accounting or monitoring systems. The system allows the extending of the solution to other data providers without major difficulties

For those pilots that don't dispose of energy accounting systems, or do not have the possibility to implement automatic data uploading, Excel templates have been developed, available for downloading in the web application, which allow easy manual uploading of monthly or hourly energy consumption data.

2) The Information System use should be made easy and clearly understandable for new and not very specialised users

Implemented solutions: A user Tutorial has been developed and incorporated in the web application of the SHERPA's Information System. The tutorial explains step-by-step the procedures for new users in accessible way for non-expert users. The interactive menus providing useful tips for the users have been also developed.

3) The Information System should permit to the user to easily adapt the menus to its own organisational structure

The problem: Each organisation or public administration using the Information System has different organisational structure, e.g. departments, sub-departments, that are responsible for some groups of buildings. Sometimes the users might be allowed to access the buildings of one department within the organisation, but not the buildings of other departments. Initially, before being able to start using the Information System the organisational structure and its individual users needed to be configured by CIMNE. The possible re-organisations or individual user changes could make this configuration very tedious.

Implemented solution: The menus and the backoffice of the Information System were re-designed in order to allow each organisation to define its particular structure and individual users within the Information System. In this way only one administrator for organisation is needed to be created and later on the administrator can complete or modify the configuration on its own. This improvement has been very important for enabling the wider use of the Information System for the next Capitalisation phase.

4) The building construction and use typologies in the Information System should cover the requirements of all pilot sites. These typologies need to be clearly understandable for all users and consistently used within the web application.

Implemented solution: CIMNE and the technical support partners IVE and CRES defined a unified set of construction and building use typologies based on widely recognised classifications. This set was contrasted and accepted by the pilots, thus ensuring overall common understanding and use among pilots.

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5) The suggested EEM by the Information System should be comprehensive and include all possible EEM that have been applied in the pilots

Implemented solution: The set of EEM offered by the Information System have been completely revised, extended and improved in order to reflect all the measures required by the pilots.

6) The Information System should enable the maximal number of comparatives (benchmarking) across the buildings within the system.

The problem: Initially the Information System has been designed to perform the benchmarking only among the buildings of the same organisation. The buildings are compared following different criteria of similarity (e.g. building use typology, location or combinations between them), producing all the possible benchmarking sets as a result. However, this approach was not adequate for organisations with small number of buildings and limited the possibilities of benchmarking for them.

Implemented solution: The benchmarking was re-designed and opened to enable comparatives across organisations, which made possible to offer quality benchmarking even for organisations with small number of buildings. The implementation of this improvement had the additional complexity of the necessity to previously implement climatic corrections before comparing the energy consumption of buildings from different locations.

7) The Information System should detect abnormal energy consumptions uploaded in the system and minimise the affectation for the analysis and benchmarking.

The problem: Sometimes the smart metering devices produce wrong measurements (single abnormally high or negative values) which when are introduced in the system might affect the subsequent data analysis and benchmarking. Similarly, human errors might be responsible for introducing wrong consumption data in manual data uploading.

Implemented solution: Although there is no practical possibility for the Information System to detect wrong energy consumption introduced by the users if the values are in the normal range of magnitudes, it is possible to detect anomalous values generated by smart metering devices (normally several orders of magnitudes higher or negative values) or highly deviated manually introduced values. Data quality check based on controlling of the deviation from the mean have been implemented (based on z-norm threshold window technique for time series data) in order to find outliers and exclude them from the analysis.

8) The Information System should allow exporting the energy consumption data from previous periods in order to support energy audits or more specific analysis in the user organisations.

Implemented solution: Methods and interfaces for exporting the data from the Information System into csv/excel data files have been implemented.

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9) The Information System should allow to export results from the benchmarking and analytics for their use in the confection of the building projects of for specific further analysis in the user organisations

Implemented solution: Methods and interfaces for exporting the benchmarking, and the information from the graphics from the Information System into csv/excel data files have been implemented.

## 5. *The SHERPA Information System*

The SHERPA Information System consists of a Common Operational Database integrated with Big Data analytics and a web Application enabling the interaction with the users from the public administrations. The system collects energy consumption data, descriptive information about each building and its use, the implemented EEM together with the related investments, and produces a variety of results supporting implementation of Sustainable Energy Action Plans (SEAP).

The system provides password-protected access for each organisation (public administration) and each organisation is allowed to access, modify and visualise only its own data, thus maintaining strict confidentiality of the information. The configuration and support of different levels of user credentials allows the setting-up of various user types in order to match the organisation's necessities, e.g. Organisation Administrator with full data access and modification rights, user with limited rights to access and modify only part of the organisation's building data, or simply visiting user with rights to access but not to modify the data.

While maintaining each organisation's data confidential, the system shares the data for analysis. In the centre of the SHERPA's system is the concept of **peer energy knowledge database** helping users to identify opportunities for energy efficiency improvement through targeted benchmarking and learning from actions applied previously in other buildings and in other organisations. The collected data processing is empowered by advanced Big Data analytics implemented over the Apache Hadoop distributed storage and parallel processing technology which permits to scale the SHERPA system to an extent of managing hundreds of thousands of buildings.

The SHERPA system is a powerful tool for public administrations. It offers single-place view on the performance of the whole organisation's building stock (through a user-friendly interface) and provides useful analytics and summaries for energy managers, policy makers and financial officers with capacity to decide on investments.

For example, features like climate-adjusted energy use comparatives with previous periods and buildings of the same typology uncover the energy saving potential and help energy managers to identify adequate actions. The quantification of energy savings and the generation of recommendations based on the estimated effect of EEM and investments applied in similar buildings help planning adequate policies and optimise financial investments. The main functionalities of the SHERPA system are listed below more detailed description is presented in D3.4.1 "SHERPA Operational Database". A schematic view of the concept is provided in Figure 3.

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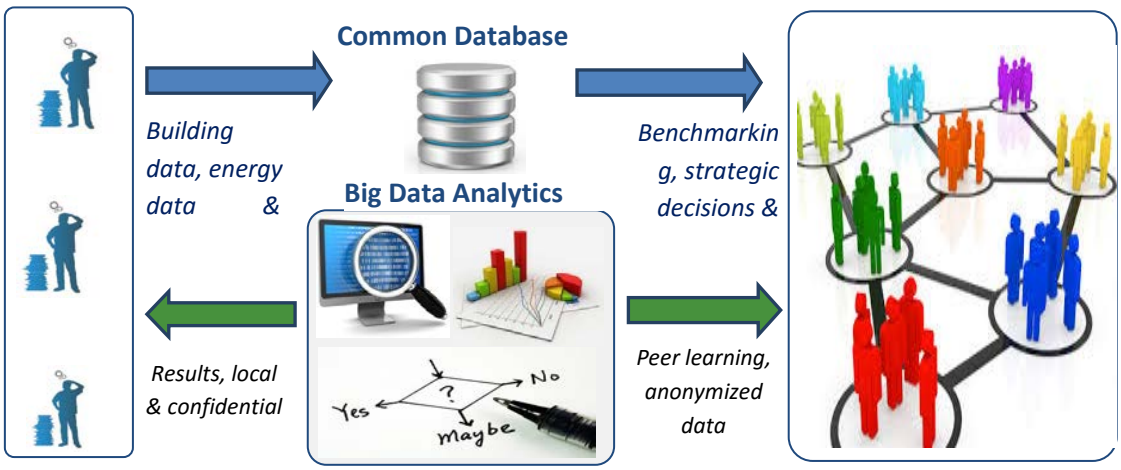


*Figure 4. Peer-to-peer approach through the Information System*

## 5.1. Data collection

The Information System collects various types of data related with the energy performance of the public buildings.

- Information about the building and its use (size, age, construction and use typology, …)
- Available energy consumption data
- Energy efficiency measures (EEM) applied
- Financial investments related with the applied EEMs

The energy consumption data can be of different granularity upon availability, ranging from sub-hourly data from energy monitoring or smart meters to monthly or bi-monthly data from energy bills.

Several different methods are available for introducing the data into the SHERPA system, as explained below.

***Introduction of data through the web Application***

The web Application allows the introduction of practically all necessary information for the SHERPA system. This comprises individual building description information, applied EEM and the related financial investments, uploading of energy consumption data in csv/excel format.

***Introduction of energy consumption via API***

In case of existing monitoring systems, the SHERPA system can acquire the energy consumption in an automated way via API. The native API of SHERPA for energy data communication developed by CIMNE is a RESTful (Representational State Transfer style) API that enables the exchange of data with virtually any type of external IT systems and databases.

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For a bi-directional exchange of data and analytic results between the SHERPA system and the external systems these have to implement the REST API client on their side. This type of connection in the project has been established with the Spanish data provider SIE.

For one-directional data exchange ensuring only data acquisition in SHERPA without returning of results to the external system, automated techniques of data exchange based on the external provider's API have been implemented. These methods offer possibilities to easily establish secure data transfer with the external systems. In the project these types of connections have been established with Dexma (international data provider) and Gemweb (Spain). The solution can be extended on demand to other data providers disposing of their own API.

## *5.2. Methodology of data analysis*

The SHERPA system is designed to work with energy consumption data granularity ranging from sub-hourly data coming from energy monitoring systems or smart meters to monthly or bi-monthly data from energy bills, depending on the availability. This makes the application of SHERPA possible in practically all organisations, including those disposing of advanced energy monitoring systems or smart meters, and those keeping only basic energy accounting.

Energy use in buildings is highly dependent on climate and weather. All comparatives and predictions in the SHERPA system are climatically adjusted. The system acquires meteorological data from hundreds of European weather stations in the service territory and seamlessly relates it with the energy consumption data and performs the necessary climatic adjustments maintaining full traceability of the calculations. Buildings are related to the nearest weather station through the postal code, which is the only information required from the user.

The data analysis in the Information System is done over the whole set of collected data in a "batch" mode, which enables discovering of usage patterns and relations between building typologies, energy consumption, effectiveness of EEM and investments. For each building the data analytics produce as much as results as possible with the available data, indicating the lack of data in case these are not complete or are necessary for further calculations. The powerful Big Data analytics technologies allow performing simultaneously multiple analyses for each building and storing of multiple results. For example, the benchmarking results are calculated according multiple criteria, so the user could compare the performance of its building with those of similar use typology, construction type, location, or a combination of these criteria. At the same time the comparatives are produced with the buildings from the own organisation and with buildings from other organisations within the system, giving the user the possibility to use the results that better match his needs.

The SHERPA´s data-driven approach is unaffected by any modelling assumptions and simplifications and permits to evaluate the building performance in real world operational conditions. With increasing the number of buildings in the database the quality of the output and the capabilities of the system increase. This is especially relevant for the benchmarking, the evaluation of the effectiveness of the applied EEMs and the planning of future interventions.

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### 5.3. Functionalities

The main functionalities offered by the SHERPA Information System are the following.

- Track energy performance in detail
- Communicate energy performance in a user-friendly manner
- Benchmark building energy use over time and to similar buildings
- Collect EEM applied together with the investments
- Facilitate peer-to-peer learning
- Manage an intervention plan for energy efficiency and suggest appropriate EEM
- Export of results

More detailed explanation of the functionalities is presented in D3.4.1. Operational database.

## 6. Conclusions and recommendations

During the work within WG2 the Information System achieved considerable progress in the development of the infrastructure and the methods of analysis. The objective of collect, transfer and treat a sample of information from 1000 public buildings was fully achieved, with 1113 buildings introduced by the SHERPA partners. This permitted the intense testing at the pilots which was essential to further mature and improve the system features and to prepare it for the next stage of wider uptake of the solution during the Capitalisation phase.

**The main achievements of the Information System within WP3-Testing include the following:**

- Development of common and extendable database capable to support strategic decisions and policies for energy efficiency measures and renovation in public buildings.

The database allows the collection of relevant building information (size, typology, location), energy consumption and EEM applied to the buildings and currently contains data from 5 Mediterranean countries (Spain, Italy, Croatia, Greece and Malta).

The implemented methods for Big Data analysis support advanced functionalities enabling strategic decision making at the public authorities by considering the specific building use typologies and the expected investments.

- A web application for user interaction with the common database and enabling peer-to-peer learning

The database is accessible for the users by means of a web application which allows identifying the most energy consuming buildings, prioritising of EEM and revealing of the energy saving potential through benchmarking.

- Various methods facilitating the building data introduction by the public authorities and automatic association with meteorological data at European scale.

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Several API-based methods for automatic data introduction in the system have been implemented in order to enable the transfer of data from existing Energy Accounting and Energy Management Systems, thus facilitating the process and ensuring the possibility of easy scaling and transfer of large data quantities in the future. Automatic data transfer has been employed in the pilots of Catalonia and Valencia, including methods for 3 different data providers (SIE, Dexma and Gemweb).

For the rest of the pilots, manual uploading of Excel file based data have been implemented, permitting to upload energy consumption data with granularity ranging from monthly to hourly consumption, depending on the availability at the public authority.

Meteorological data needed for the energy performance analysis and benchmarking was made automatically available in the system ensuring connection to European scale databases. The association of a specific building and the nearest meteorological station required only the introduction of the postal code of the building location.

**The principal difficulties for the testing in WG2 have been the following:**

- The availability and collection of building data at the pilots proved to be the main difficulty in the testing of the Information System

The availability and access to building data has been difficult, as in most of the cases the participating pilot partners are not directly managing the buildings and rely on external regional or municipal organisations to provide them. This has been the situation in Crete, Dunea, Valencia, Abruzzo, Emilia-Romagna. For the residential building typology, which is represented in the building stock of some public administrations, the electricity data was only available for the common parts of the buildings as the rest of the data is registered by the private energy meters of the tenants and the pilot partner didn't have access to them. This situation was present in Emilia Romagna and Catalonia.

Data quality introduced in the system was not always good and in some cases included gaps or errors, sometimes from automatic reading devices.

The available information about EEM applied in the buildings has not always been available or fully complete. In many cases the date of application of the EEM could not be exactly specified, or the investment related with it was not available. In practice, most of the introduced EEM in the system dated from periods before the available energy consumption which didn't allow any useful quantitative analysis.

- The effective testing at the pilots started later than expected

Although the testing activities in the project started as scheduled, the effective testing of the Information System with data was delayed, mainly due to the delay of collecting and introducing the data in the common database.

Another factor for the delay has been the complexity of the internal organisational structure and communication at the participating public administrations, where the activity of the staff involved in the pilot testing from the regional organisations depended on external

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energy managers for obtaining the data.

At last, the complexity of the Information System and its underlying concepts made the learning curve less steep, taking more time than initially expected to fully understand the operation and avoid some errors.

- Technical and modelling difficulties / Difficulties for analytics and modelling

The data-driven modelling and machine learning approach of SHERPA relies fully on the analysis of the data set within the operational database. This approach doesn't rely on any pre-established theoretical models or suppositions proved to have limited performance for predicting real building behaviour, sometimes with deviations above 30%. However, the not sufficiently complete data set available in the database during the testing period has limited the possibility to fully test some of the developed features. For example, the evaluation of the effect of single EEM applied to a building has been possible only in 4 cases, as the SHERPA system didn't dispose of energy consumption data previously to the date of the applied EEMs in more buildings. Nevertheless, it is expected that with the further completing of the data set and the increased number of buildings expected in the capitalisation phase this problem will be overcome.

**Most useful features of the Information Systems according the pilot feedback:**

- Benchmarking – for revealing the energy saving potential
- Identifying the most energy consuming buildings for prioritising EEM and investments
- Suggestions for EEM and the expected investments for them based on the already applied measures in other buildings
- Follow-up of energy consumption evolution with respect to previous periods and its response to applied EEM

**Recommendations:**

- Increase the data quantity by introducing more buildings and EEM into the system. This will substantially contribute to improving and extending the outputs of the Information System.
- Maintain high quality requirements for the introduced data through more control by part of the users is very important. The quality of the introduced data is essential for the data-driven approach of SHERPA.
- One of the most important features to be incorporated in the Information System is the evaluation of savings from single EEM. In fact, this has been implemented by CIMNE as a model, however the still insufficient data about EEM coinciding with energy consumption data (previous and after the EEM) hasn't permitted to properly train and validate the model in large scale applications. It is expected that in the next phase of the project the evaluation of savings could be adopted as a permanent feature of the Information System.
- The data-driven approach of SHERPA for providing recommendations and evaluation of savings from EEM based on real data has considerable advantages over methods based only on simulation, which sometimes predict energy consumptions that deviate substantially from the real ones. However, reliable data-driven

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predictions need big data sets and are influenced by the data quality. In practice, not all of the building typologies and EEM are equally represented in the system and there is no existing data for some of them. As a consequence, in these cases predictions cannot be generated. In the future the wise combining of the data-driven approach of SHERPA with simulation-based approaches, as for example the one offered by the IMPULSE project, could considerably contribute to closing the gap between the predicted and real consumption. Additionally, the incorporation of Best Available Technology knowledge databases in the SHERPA Big Data system could improve the recommendations for EEM to apply. This at the same time would considerably improve the user experience and confidence, which are important factors for the wider adoption and sustained usage of the services in the future.

- Data is difficult to collect and this takes more time than expected to establish continuous feed to the Information System. Nevertheless, the project has already created strong impulse among the participating organisations and a lot of other MED regions and municipalities. It is necessary to maintain the efforts and ensure financial support to maintain the initiative operative beyond the project lifespan. Although the running costs per user for large number of users are low, it is necessary to pay hosting and maintenance services.