D6.2 Methodology for the Implementation of ICT-based Energy Efficiency Solutions targeted for European Social Housing

Version updated after the 3°project review

Author(s):		
	Thomas Messervey	**D'APPOLONIA**
	Margherita Scotto	**D'APPOLONIA**
	Andrea Pestarino(*)	**D'APPOLONIA**
	Regis Decorme	**CSTB**
	Jose Luis Buron	**ACCIONA**
	Javier Mardaras	**ACCIONA**
	Piotr Dymarski	**MOSTOSTAL**
	Nicolas Salmon	**NOBATEK**
	Idalia Torres	**ISA**
	Jorge Landek(*)	**ISA**
	Martyna Sikora	**City of Warsaw**

(*) co-authors of the updated version May 2013

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Disclaimer

Summary

"D6.2 – Methodology for implementation" is a public document delivered in the context of WP6 – Global methodology. It describes the methodology for the implementation of ICT enabled energy conservation measures developed within E3SoHo project.

The methodology for implementation is written to guide stakeholders through the planning and execution steps of the installation activities associated with ICT energy efficiency solutions for social housing. Examples include communicating with the tenants, scheduling power cut-off times, verification of system functional status, and so on. Although social housing is targeted, many of the implementation aspects can be transferred to other building and stakeholder types.

One special area of focus in this deliverable is Awareness & Training. In E3SoHo, as in many other residential ICT implementations, the focus is largely upon user behaviours (as opposed to changing the energy infrastructure or building retrofit). For such applications, each interaction with the stakeholders (whose behaviours are being targeted for change) can and should be used as an opportunity to educate and inspire them about the process and equipment that will lead to a more sustainable future (and reduced energy costs). Within, recommended actions and documentation examples are provided.

A second area of focus in this report is the installation activities at the three project pilot locations. They provide concrete examples of successes, challenges, lessons learned, awareness and training activities, and costs. At the time of the preparation of this report, installation activities are being concluded at each of the pilot locations with the fielding of dashboard tablets/screens that allow the users to interact with their ICT system. Previously, ICT hardware devices have been installed in the homes to establish energy related performance indicator baselines. With this fielding, each tenant will have the opportunity to interact with their system.

D6.2 provides the details for the second part of the global methodology that will be developed during the project and will be composed by four deliverable submissions: methodology for design (already delivered 6.1) methodology for implementation, methodology for monitoring, and global methodology.

Abbreviations

AEEG	Authority for Electricity and Gas
APT	Apartment
API	Application programming interface
ARTE	Azienda Regionale Territoriale Per L'Edilizia Della Provincia Di Genova
BEM	Building Energy Management
DHW	Domestic Hot Water
E3SoHo	Energy Efficiency in European Social Housing
ECM	Energy Conservation Measure
EEB	Energy Efficiency in Building
ESCO	Energy Service Company
Esesh	Saving Energy in Social Housing with ICT
HVAC	Heating, Ventilating, and Air Conditioning
ICT	Information and Communication Technologies
IHD	In Home Display
IPMVP	The International Performance Measurement & Verification Protocol
M&V P	Measurement and Verification Plan
PDAC	PLAN-DO-CHECK-ACT
ROI	Return On Investment
3-E Houses	Saving Energy & the Environment across Europe

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1. INTRODUCTION

The overall objective of E3SoHo project is to implement and demonstrate in Social Housing pilots an integrated and replicable ICT-based solution which aims to bring about significant energy savings, reduced carbon emissions, peak shaving. Surrounding this solution are services related to building assessment, system design, system implementation, awareness & training, and the assessment of energy savings. In this report, the implementation phase of ICT energy efficiency retrofitting is addressed. Activities include planning the installation, conducting the installation, and supporting it through awareness and training activities.

After this introduction, **Chapter 2** (From Design to Implementation) addresses the period between the design and implementation phases with focus on change management, selecting technology providers, and the tendering process. **Chapter 3** (Planning the Implementation) continues with the pre-installation activities required to ensure successful onsite installation activities. These include permissions, scheduling, software pre-configurations, and final technical visits (amongst others). In **Chapter 4** (Conducting the Installation), the experiences of an installation team are captured to provide one example of best practices in the processes that occur on site during installation activities. Major steps include communication, scheduling, hardware installation, system verification, and closure actions. **Chapter 5** (Awareness & Training Activities) transitions to supporting and reinforcing the installation with the processes and materials to make stakeholders and users aware, familiar, and comfortable with E3SoHo services and solutions.

Chapter 6 (Individual case study) It provides the methodological steps conducted at each of the three E3SoHo pilot and for each an analysis in terms of key partners involved, key activities, key resources, Value preposition, channels, costs and lesson learned was performed.

Chapter 7 (Methodology: From EU Project to Industrial Business Services) completes the document and is dedicated to knowledge transfer and how the project methodology becomes generalised and replicable for others implementing energy efficiency ICT implementations.

2. From ICT Solution Design to its Implementation

2.1 Managing Change

Typically, between design and implementation, there are two factors that may often lead to changes from the original plans and designs:

- **Time**: Typically, the more time that passes between the design and implementation phases, the more likely one will have to manage change. Reasons for delays often include fund allocation procedures, tendering processes, stakeholder schedule availability, hardware availability, personnel transition, and so on. If recognised as a risk, the probability and impact of time delays can be reduced.

- **Adaptation to Field Conditions**: Designs are plans. All plans require adaptation during the execution phase. The more detailed, effort intensive, and supported a design process is with accurate field information, the less adaption of that plan will be required as it passes to execution.

Regardless of one's ability to mitigate risk, it will not be possible to eliminate change entirely. As such, it is necessary to establish change management procedures and to conduct risk reduction measures to reduce the impact of change once equipment fielding begins. Best practices include:

- **Equipment**: There should be extra allowances for miscalculations, damages, and non functional items.
- **Purchasing**: A mechanism should be established to allow expedient purchases of hardware and/or supporting materials needed on site.
- **Decision making authority**: The decisions the installation team can and cannot take should be established and clear. Purchasing limits and permission procedures should be documented.
- **Communication**: Practical means of communication (availability of cell and land lines), the frequency of communication, and expected reporting content must be clear.
- **Technical Expertise**: The difference between technicians that can do what is planned to do on site and technicians that can adapt to what actually occurs on site has a high impact to implementation success and reducing the impact of change.

2.2 ICT Hardware and Software Provider Selection

As with any purchase, one must consider different alternatives. Life-cycle aspects should be considered although initial lowest cost is always a primary driver. The purchasing process itself (direct selection or tender) is important and directly correlated to technology selection, its installation, and what happens once the system is put into operation.

2.2.1 Direct Selection: One chooses the solution provider

With **direct selection**, one has the ability and/or responsibility to locate and choose a solution provider. Aspects associated with direct selection include:

- Greater flexibility (the ability to customise and/or mix vendor solutions)
- Faster process
- Potentially a lower cost (but higher risk of unforeseen problems)
- Potentially more responsibility with the installation and maintenance actions

The implication is that the decision maker (the one who selects) is more deeply involved in the process.

2.2.2 Indirect Selection: The Tendering Process

Social housing stakeholders may by law be required to implement a tendering process. A public tender is an administrative contract established with a public or private organisation and answering a need of service or work. Rules and regulations will vary from organisation to organisation and from country to country. For example, in France where the E3SoHo project originally had a pilot planned, this was mandatory (for all state-owned and public organisations) and needed to comply with the rules contained in the public tenders code – "Code des marchés publics[1]". In Spain it is mandatory to follow the tendering procedures to all public bodies for services and supplies from 18.000 € onwards according to the Public Procurement Low: LEY 30/2007, Ley de Contratos del Sector Públicos. Contratos de las Administraciones Públicas. BOE 31 octubre 2007, núm. 261, Modificada Ley 2/2011, de 4 de marzo. http.// www.cert.fnmt.es/legsoporte/**Ley**%20**30-2007**.pdf. In Poland it is mandatory to use the tendering procedures to all public orders higher than 14000 Euros according to the Public Procurement Low with can be found at http://www.uzp.gov.pl/cmsws/page/GetFile1.aspx?attid=4078. This law, in principle, must be used by all public sector entities and also all entities outside the sector public finances, provided that reassembles the contract is financed in over 50% from public funds. In contrast, in France, if the cost is lower than 4000 euro, no compulsive tendering is required. Finally in Italy the requirements for public contract for construction, services and suppliers are described in the following laws: legge quadro "Merloni" 11/2/94 n.109 now Decreto legislativo 12/04/2006, n. 163 Regolamento generale D.P.R. 21/12/99 n.554 now D.P.R. 5/10/2010, n. 207. In particular with reference to the definition of suppliers of services is stated within the art. 267, c.10 del Regolamento D.P.R. n. 207/2010) that for services lower than 20.000 € the assignation could be done directly by the RdP (Responsabile del Procedimento- responsible for the specific project)

[1] http://www.legifrance.gouv.fr/affichCode.do?cidTexte=LEGITEXT000005627819&dateTexte=vig

without tender procedures (after the verification that the potential supplier satisfies the selection requirements).

A starting point for EU and country specific tendering processes can be found at http://europa.eu/policies-activities/tenders-contracts/index_en.htm.

The first step for setting up the public tender is to define the needs, nature, size and scale. The needs can be either supply or work contracts. Once the needs are defined, the public tender must be advertised. Advertising ensures the dissemination of the public order and allows a real market competition. The buyer can select the most adequate and relevant advertising channel (press media, Internet, display, etc.), although some strict rules may be established for tender amounts above certain thresholds. Remaining with the example of France, if the tender amount is greater than 90.000 euros, a publication in the BOAMP – "Bulletin Officiel des Marchés Publics" - the French official bulletin of public tenders - is necessary. In case the threshold is higher than 125.000 euros (supply contract) or 4.845.000 euros (work contract), a publication in the official journal of the European Union (JOUE) is also requested. For those publications, the buyer must use standardised forms (provided by the French Ministry of Economy, Finance and Industry) to write its announcement, which are designed to increase the global homogeneity of the public tenders and to limit the language barrier factor in the case of EU publications. In Poland such notices, referred to circumstances in with tendering procedures are required, shall be placed in the Public Procurement Bulletin available on the portal of the Public Procurement Office, in standardized by the Prime Minister forms, or if the threshold is higher than 200.000 Euros (supplies or services) or 5.000.000 Euros (work contract) shall be published in the Official Journal of the European Union.

Once the offers from different competing candidates are received, the following steps are followed: verification of the candidate integrity (mainly financial situation of the company); technical analysis of the offer; financial analysis of the offer; negotiation. The buyer must select the "most advantageous economic offer". It means that the price may not be the only criteria for selecting between the different candidates; also the quality of the technical content proposed is evaluated. Specified and required evaluation criteria may be listed and included in the tender. Once selected, candidates are then informed of the final decision, and a purchase order is then established with the selected winner.

With **indirect selection**, one has the responsibility to establish and follow the appropriate tendering process. Aspects associated with indirect selection include:

- Work of preparing and executing the tender
- Being one step removed from hardware/software selection
- The ability to compare and contrast different alternatives
- The ability to hold the tender winner responsible for system installation, unforeseen problems, installation and after installation actions

- Slower process
- Potentially a higher cost (but lower risk for unforeseen problems)
- Potentially less direct responsibility for installation and maintenance actions

The implication of the tendering process is that someone else is likely taking a share of the responsibility for a successful implementation and is being provided a premium to do that.

2.3 Decision making criteria

Project report "Deliverable 2.3: Best Technical and Cost-Effective ICT Solutions Identified" identifies technology types and where to get additional information related to energy efficiency ICT solutions. In the following table, several decision making criteria are identified to stimulate thinking about aspects to consider in selecting technologies and/or the method in which to select them (direct selection or tender).

ICT Solution Hardware & Technology Decision Support Criteria	
Initial Cost	Initial cost
Life Cycle Cost	Initial cost + operational cost (power consumption) + maintenance / inspection cost + replacement cost (if required)
Performance Guarantee	What is guaranteed, for what economical terms, for how long
Responsibility for Installation	Are technicians for installation available in the organisation or must this work be contracted?
Responsibility for Awareness & Training	Who is the expert of the system? Where are they located? What is their availability? Does the organisation need to invest the time to become expert?
Technical Performance Characteristics	Range, accuracy, precision.
Services Offered	What does the system do and how does it compare to others? Are the services those that are needed?
Ease of use	Is it intuitive? Easy to use? Bug free? Established and tested or first version?
Compatibility	Can it integrate with on-site systems?
Expandability	Can it be expanded easily in the future?

3. Planning Installation Activities

3.1 Permissions

Failure to obtain permissions can bring installation activities to a halt and result in wasted person hours. Although it may seem simple, the difficulty of permissions should not be underestimated. It is best to initiate the permission process as early as possible and ideally long before implementation activities.

3.1.1 From utility companies

As a general rule, utilities must approve modifications to their meters and/or hardware. Electrical boards, junction boxes, and metering points often have signs posted with numbers to call if access is needed. Utilities may object to the installation of ICT hardware because:

- they do not want anyone tampering with their devices
- they do not want any implied safety risk whatsoever
- they do not want competition to a service they potentially also offer.

Permissions required may depend upon the type of metering device installed, where the meter is installed (inside the home or at the collective junction boxes outside the home), and what is being metered. Electricity, gas, and water carry different types of risks and have different regulatory requirements. Utilities (once asked) may require a substantial amount of time to process permissions or to understand what is being done and what is required to grant permissions for installation.

3.1.2 From the local building manager

It is best to make the maintenance and technical staff part of the installation process and to gain their support about the benefit of the work being conducted. This staff provides knowledge of the local facilities, access to mechanical rooms and utility points, and know-how about what works and what doesn't work. Their support will also likely be required to disconnect (or shut off) electricity, gas, or water in a coordinated manner during the appropriate times during installation activities.

Building managers might object for various reasons. These objections may include:

- It is different and requires additional work
- Scepticism about the utility of proposed solutions
- Not wanting outside eyes viewing internal procedures
- Previous bad experiences.

These objections should be addressed in a deliberate manner. It is possible (and likely) that establishing communication networks will require running cable, drilling holes, and changing the aesthetic appearance of the building (although in a minor way). The technical staff will likely also be left to handle problems that arise with equipment over time or with routine maintenance actions. The better they are integrated into the implementation phase, the more successful the long term performance of the system is likely to be. It is also not uncommon that local solutions to problems that have occurred in the past are not textbook solutions. In specific, to keep services running or due to a shortage of funding, conditions may exist in the buildings that the local staff would rather keep internal and not subjected to the opinions and views of external bodies.

3.1.3 From tenants

Tenant participation in ICT energy efficiency services initiatives can range from them paying for such services to being "forced volunteers". The most likely scenario is that tenants are provided such services as part of their apartment contract and pay for them in an indirect way (e.g. through facility fees or a slightly higher rent). Because a primary goal of ICT enabled energy efficiency services is to influence tenant behaviours, it is best to invite and attain tenant support and "buy-in" as early as possible. This also relates to the training and awareness program as each interaction with tenants should be utilised to invite and inspire energy efficient behaviours (Chapter 5).

Basic permission from tenants includes:

- Permission to enter and install equipment in homes
- Permission to switch off electricity, water, or gas during the installation process
- Permission to collect and analyse energy and behaviour related data.

Objections to implementation procedures are related to these permissions and may include:

- Privacy concerns related to energy consumption data
- Aesthetic concerns related to the installation of sensors and potentially new electrical boards in the home
- Resistance to change and/or doing something different
- Related to the previous point, and very frequent with elderly tenants, the fear or dislike of technological devices such as computers, tablets, etc.
- Additional costs of maintaining such electronic equipment – higher energy bills
- Fear of financial responsibility for the quite expensive ICT equipment.

The simplest way to overcome or avoid tenant objections is to make them part of the rental agreement. The most effective way to overcome the potential objectives of tenants it to inspire them about program objectives.

3.2 Scheduling

Implementation activities require the coordination of all stakeholders in the value chain. Poor scheduling can directly damage program objectives (by losing support of tenants and/or key individuals), desynchronise the implementation schedule, create delays, and waste resources. For these reasons, a deliberate approach to scheduling is a critical step and part of implementation activities.

3.2.1 Developing & Communicating the Installation Plan

The installation plan should be developed in a manner that is logical, transparent, and feasible. Stakeholder activities should be coordinated such that time is not wasted, access is granted when needed, and services are disrupted for the minimal required amount of time. One best practice to facilitate coordination can be to establish the communication infrastructure outside of the dwellings, to install all supporting hardware outside of the dwellings, and then to conduct activities which require access inside of the dwellings. Qualities of a good installation plan include:

- Clear and easy to understand
- Available beforehand and posted in common areas
- Acknowledgement of the schedule should be confirmed by tenants and stakeholders granting access
- Version number or and last update indicated
- Phone numbers and contact data for key individuals listed.

3.2.2 Access to utility and common areas

Special attention should be given to utility and common areas. Utility areas often require coordination for access and common areas often serve as places for command and control. In both cases, persons not directly involved with the installation activities are those providing access. Because implementation activities may run ahead or behind schedule, it is important to ensure that these persons are kept aware of progress, that they are given priority of effort, or that a mechanism to contact them when needed is established.

3.2.3 Tenants

Special attention should also be given to the tenants. Tenants should have a clear understanding of:

- The intervention schedules
- What is being installed by which company
- When and what utility services will be disrupted
- Who and how they should contact the installation team in the event they become unavailable.

A best practice is to have someone from the local facility in frequent communication with the tenants keeping them informed of the progress of the work. It is also common that tenants will want to welcome, host, and offer the installation team water, coffee, food, etc. Depending on the nature of the schedule, although nice gestures, such activities can delay the work.

3.3 Final Technical Visit

The level of rigor required of the final technical visit is a function of the level of detail attained during the design process and the amount of change in the period between the design and implementation phases. As this will change from one case to another, it is not possible to describe what should happen during the final visit. However, it is possible to provide several aspects of what should be clear and established by the time the final technical visit is completed.

- Scope of implementation activities defined
- Stakeholders and tenants identified and notified
- Stakeholders and tenants should be made aware of any pre-installation activities required, program objectives, and general flow of work
- Verification of the list of equipments to be installed
- Specific safety measures to be taken if necessary (for example old electrical box to be repaired before intervention)
- Local radio communication study (if wireless sensors to be installed)
- Verification of specific issues concerning building access if needed
- Evaluation of specific onsite actions if needed (for example wall drilling or adding other electric supply in common areas)
- Identification of potential barriers from both a technical and a human point of view.

The technical visit should be a direct walk through of all areas where implementation activities will take place. As a final check, "General Information" and "Site Visit" checklists can be utilised to ensure critical matters are not forgotten.

General Pilot Information

- Building typology (detached home, apartment, complex)
- Number of buildings, dwellings per buildings and number of rooms per dwelling
- Surface area (liveable/total)
- Occupation data
- Synthesis of the equipments and if possible localization: heating, DHW, Ventilation, air conditioning, renewable, lighting, electric system, ICT/BEM

security others

- Structural drawings of the building
- Plant and mechanical drawings of the building (electricity / plumbing / ventilation)
- Internet connection or mobile signal coverage

Site visit

For each parameter such as Heating – Air Conditioning, DHW, Ventilation and Renewable both for each dwellings and common areas (where applicable) is necessary to collect technical specification such as:

- General info: Brand/Model/referente
- Rated power consumption
- Type of energy
- Individual or collective
- Counter type
- Localization
- Photos

For each dwelling is important to take note of further details such as:

- Configuration of the electrical board and the types of output
- Type of lighting system, number of lights, rated power
- Windows: type, dimension, orientation, localization
- Appliances present: TV / hi-fi / video, computer, dishwasher, washing machine, drying machine, oven/stove, microwave, fridge, freezer
- Wall structure
- Internet connection availability
- Particular pathologies (humidity, windows broken, malfunctioning of some devices, etc.)
- Other comments

If measurement systems are already in place during the visit, it is necessary to collect technical information related to sensors, meters, weather station, data loggers, communication equipments and local servers.

If measurement systems, BMS, or other ICT systems are present, it should also be collected the types of systems/devices used, protocols employed, communication infrastructure and means of communication used, data security procedures, data management procedures, and component interoperability (e.g. are data from such systems available, in what format, and can the devices be integrated into a larger network).

3.4 Preparation and pre-configuration of Installation Materials

An easy step, but important to include as one may neglect or underestimate what should be prepared or pre-configured prior to on-site activities.

3.4.1 Paperwork

The following paperwork should be organised in adequate quantity, be potentially pre-filled out for basic data, and potentially be bundled per apartment.

- Permission forms (if not already attained)
- Service log-in credentials and information (if required)
- Awareness & Training materials
    - Program overview information
    - FAQ and contact information
    - User Manuals
    - Technical Data Sheets
- Acknowledgement of receipt for hardware (if utilised).

3.4.2 Hardware & Software

Hardware and software from different vendors may be integrated into the final ICT solution for any specific site. In the case of the E3SoHo pilots, small hand-held tablets with internet capability were purchased for the tenants to enable them to view their energy consumption data online. These tablets had to be configured to the online portal (SAAS) of ISA for consumption profile viewing. Such actions are best done off-site so that time (or confidence) is not lost with the tenants.

3.5 Communication Aspects

In this section, communication aspects are deliberately highlighted. This is done because communication is likely the aspect that becomes problematic, is addressed in a general way in the design phase, or is underestimated. Revisiting the communication architecture and plan during and after the final technical visit is a best practice.

3.5.1 Wireless and Wired Networks

With reference to how planning and designing any communication network in order to allow off-site data management and data processing, different issues need to be accounted for:

- Wired or wireless sensors and meters
- Wired or wireless connection among sensors and dataloggers

- Wired or wireless communication among dataloggers and routers
- Wired or wireless communication among routers and data storage and analyzing server
- Wired or wireless access from tenant user interfaces (such as tablets) to remote services.

To comply with the aforementioned issues, the availability of a "permanent" Internet connection (DSL, dial-up, ISDN) in the building and dwellings area needs to be checked. In the instance of a "permanent" Internet connection, "temporary" solution may be identified by installing wired connected Internet modems, such that they are close to the data loggers and sensors, or wireless Internet modems, which allows for more flexibility in the location of the devices.

Wired or wireless sensors and meters

The sensors and meters are the monitoring devices in each sensor network. The first issue to be faced when designing such type of network, which comprises temperature, humidity, gas, water, open window sensors, is to define the sensors location in dwellings and buildings and to identify how the sensors are connected to the monitored element. In doing so, the solution should be non-invasive and avoid, where feasible, the use of cables, fixtures, mounting elements, and so on. When possible, wireless sensors are preferable although power requirements (batteries) and data transfer reliability are potential drawbacks.

Wired or wireless connection among sensors and data loggers

The data loggers are the data collection point in each sensors network. The sensor communicates directly with the data logger by using different protocols depending on the sensing unit. To exemplify, the ISA iPoint sensor (temperature and humidity used in E3SoHo) uses Radio Frequency (RF), the data logger iHub uses RS485 (wired) and RF (e.g., Zigbee based on an IEEE 802 standard), the smart plugs uses Zigbee and the electricity counters uses RS485. Once the datum is collected by the data loggers, it is transmitted to a device (router) enabled with Internet or mobile connection.

Wired or wireless communication between data loggers and routers

The routers are the on-site data transmission point in each sensor network. The router provides the data transmission from the data logger to the data storage medium for processing and analysis (on-site computer or off-site server). The router must therefore be part of a Local Area Network (LAN) or be internet enabled. Among the different data communication protocols, especially for those without any "permanent" Internet connection, 3G High Speed Packet Access (HSPA, HSDPA High-Speed Downlink Packet Access and HSUPA High-Speed Uplink Packet Access) are good solutions. The router can be wire connected to the data logger or can be wirelessly connected to avoid cabling requirements. Of interest, new wireless routers allow for 3G HSPA Internet connection, providing data transmission by integrating a modem and a slot for a Subscriber Identity

Module (SIM) card. At the time of this report, HSPA supports increased peak data rates of up to 14 Mbit/s in the downlink and 5.76 Mbit/s in the uplink while providing effective latency reduction.

Wired or wireless communication among routers, data storage and/or the analyzing server

The router is the link to send the data collected by data logger to an off-site web server which provides data storage, data analysis and data displaying functionalities. The way the communication between the data logger and server is realized is through the Internet protocol (TCP/IP) the router adopts. This item has been explained in the previous paragraph where the adoption of a 3G HSPA communication protocol has been suggested. This solution is a very feasible one when a "permanent" Internet connection is not available at the installation site. Indeed this solution provides a "temporary" connection, whose quality depends on signal coverage which may vary, depending on the location of the building or location within the dwelling (similar to cell phone coverage).

Wired or wireless access from tenant user interfaces (such as tablets) to remote services

One important aspect that must not be overlooked is the way that user interfaces to be used by the tenants (e.g. within the E3SoHo project a tablet has been selected as the main way of providing information, alerts and advices to the tenants) will access to internet enabled remote services, through which energy awareness, behavioural changes and energy savings will be achieved.

Although there are other user interfaces where communications infrastructure is not an issue (e.g. alerts through SMS to the cell phones of the tenants, or smartphone applications), it will be very frequently the case that a project decides to install as user interface a dashboard, tablet, display, etc. which needs to have internet access in order to provide a set of services (energy consumption information, alerts, advices, etc.).

In the context of social housing it cannot be taken for granted that each tenant will have an internet access that can be used by the user interface deployed in the project. It is therefore mandatory to plan also the communication infrastructure necessary for providing internet access to the user interfaces. Generally one of the following three options will be chosen:

- **Wired connection:** if the user interface has Ethernet port or similar, it can be wired to the internet router that will be generally installed for the communication infrastructure of the global ICT solution. This solution is the very reliable but also the most intrusive and complex to deploy
- **WiFi connection:** most frequently the user interfaces will be WiFi enabled, so a good option is to deploy a WiFi network to be used only for the project purposes, not for general Internet browsing. WiFi network design needs to be done carefully in order to guarantee coverage for all the tenants while optimizing the number of WiFi access points of repeaters needed

- **3G HSPA connection:** other option is that the user interface has a slot for a SIM card, and then it can access the internet through 3G HSPA connection. This is the most easy to deploy alternative, although probably the most costly one since it will be normally necessary to contract an internet data tariff for each tenant with a 3G provider.

3.5.2 Data Security and Data Management

Data security and data management are two further issues that any communication network has to face. This implies planning and designing appropriate strategies to guarantee the security of the collected and transmitted data and to ensure the management of these data once they need to be stored, analyzed, processed and displayed. Data security also implies that data is kept safe from corruption and that access to it is suitably controlled.

Data management and security are part of a data management system, which also account for:

- data access
- data governance
- data analysis
- data quality assurance
- data integrity
- data administration
- data recovery and remote control.

The complexity of such a system is directly correlated to the system architecture, interrogation frequency, and number of dwellings managed. Procedures should also be identified for data loss, signal interruption, system backup, and the detection of abnormal information and/or overload in service operations.

In E3SoHo, the employed solution is designed to implement access control, data check, and data quality integrity procedures and data recovery. Data recorded on-site is sent to an off-site web server which manages processes, analyzes and displays them ensuring a certain level of confidentiality. Users can access to the server and can display the data based on hierarchic levels of access. Data security is ensured in two ways: user authentication with a secure token based on username and using a SSL certificate encrypting the channel and communicating through HTTPS (Hypertext Transfer Protocol over Secure Socket Layer).

3.6 Planning Aspects for the Measurement and Verification Campaign (IPMVP)

If the solution provider, tenants, or stakeholders want to assess/quantify the energy savings benefit of the implemented ICT solution and services, then a deliberate measurement and verification plan must be implemented to do that. Although overlap and synergy can be attained from sensors providing data to both systems, it is simplest to think of two separate systems, one to achieve energy savings, and one to measure the energy savings of that system through before and after comparisons that isolate and normalise data associated with the retrofit (e.g. to strip away affects of other interventions such as new windows or a larger family living in the home consuming more energy or different weather conditions).

In Deliverable 6.1 "Methodology for the Design," Chapter 3 is dedicated to the International Performance Measurement & Verification Protocol (IPMVP). Within the report (D6.1), the protocol, its intent, and the 13 step measurement and verification planning process is detailed as it applies to E3SoHo. This 13 step process covers all phases of an energy efficiency investment/conservation measure beginning with the intent and finishing with the final report of the energy savings assessment. In this current report (D6.2), aspects related to the implementation phase are highlighted. This logical sequence is continued in the next project methodology report, Deliverable 6.3 "Methodology for Monitoring," where aspects related to data collection, data processing, and energy savings assessment calculations will be treated.

Installation activities typically mark the beginning of the implementation phase. Using IPMVP, this is a critical point in time (as shown in the following diagram) because it is the dividing line between the **baseline period** (before) and the **reporting period** (after).

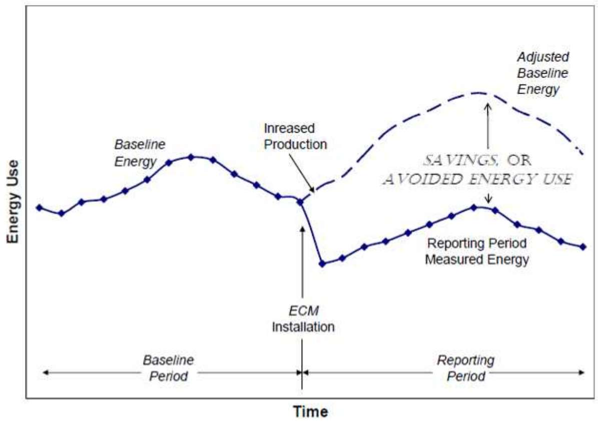


Figure : IPMVP Division of the Baseline and Reporting Periods by Installation Activities

The 13 steps for the planning and execution of IPMVP are:

1. Energy Conservation Measures (ECM) intent
2. IPMVP option and measurement boundary
3. Baseline: Period, energy and conditions
4. Reporting Period
5. Basis for adjustment
6. Analysis procedure
7. Energy prices
8. Meter specifications
9. Monitoring responsibilities
10. Expected accuracy
11. Budget
12. Report format
13. Quality Assurance

During installation and the activities that support it, it is appropriate to revisit the following steps from the design phase:

IPMVP Planning Steps	Installation Planning Action
Step 2 Isolation Step 4 Adjustment Step 5 Analysis	Do the metering point's data support the isolation of the retrofit as intended during the design process? Do the planned measurements still support the performance indicators selected and basis for adjustments (e.g. weather data, occupancy information, etc)?
Step 3 Baseline	Has the collection of baseline information been adequate / completed? Are control groups needed if not? Are additional measurements needed if not?
Step 8 Meter Specifications	Are the metering points and types of planned sensors still consistent with the original design after any potential changes or as a result of the final technical visit?
Step 9 Monitoring Responsibilities	Who is responsible and data collection, processing, and analysis? Who is responsible for maintenance actions?
Step 11 Budget	Are budgetary updates required?

4. Conducting Installation Activities

4.1 Communication or Initiation Briefing

All the stakeholders have an important role in the context of the installation process. As such, it should be made clear and available the role and expectations of each stakeholder as installation activities begin. This can be done in a flyer handout or best in an information briefing to enable face-to-face recognition of people that will be in and outside of the homes, installing cables, accessing equipment, etc. A briefing also enables an opportunity for questions and likely saves the installation team time during installation activities by not having to answer similar questions repeatedly or by not being provided access due to suspicion or unfamiliarity with the schedule of events. Such a briefing also enables the distribution of awareness and training materials instead of them potentially needing to be carried and delivered one by one during the installation visit.

4.2 Hardware Installation

The first action is to build the communication infrastructure, if the building has cable mats available to use the installation use this infrastructure to pass cable from the internet access point to the different data loggers. However if the infrastructure does not have this kind of structure it is necessary to design the best way to pass the cable. This second option takes more time than the first one.

Another relevant issue, considering the devices that communicate using radio frequency, is that it is also important to ensure communication between each device and the data logger. In this case, one approach is to use repeaters that will replicate the signal. This solution is not always the best if the devices are far from the concentrator. In this case, it is typically desirable to install another concentrator, ensuring the reception of the signal. This procedure is validated using a software (in ISA case) that allows to detect the devices in the network and forcing communication in order to receive data and ensure if the installation is ok or if it is necessary to make corrective actions.

Inside the dwellings, where it is possible to monitor partial electrical circuits, it is important to implement the correct number of meters in order to install other electrical board as small as possible.

The devices for outside the dwellings have specific requirements to be installed. In the case of the weather station (usually installed in the roof) is necessary to measure the diagonal of the top of the building and calculate the height that will be necessary to ensure the correct operation. Concerning interferences with the system, it is important to understand if there are existing antennas near the forecast location for this device. This procedure is consequence of one lesson learned from the Zaragoza pilot, where in the roof exists a TV antenna that interfered with the weather station installed influencing the communication and the reception of the correct values. For that reason it was necessary to change the location of the weather station far from this antenna.

Figure 1: Weather station and TV Antenna in Zaragoza Pilot

For monitoring the general electrical consumption, usually the counters are outside the dwelling, it is necessary to cut the power distribution for a period not exceeding 30 minutes. Before doing this, it is necessary to inform the tenants in advance so that ensuring this cut off does not influence the correct operation of the electrical equipment available inside the dwellings.

Other important parameters are the domestic hot water, gas and water consumptions. If the counters of this parameters support telemetry, the installation is very simple and it is necessary only to install the meter without any cut or any other action beyond the communication verification. On the other hand in the case the counters do not support telemetry it is necessary to understand if is possible to install an accessory or if it is necessary to change the counter. In both cases it is necessary to involve the utility or, if no permission is obtained from the utility, to put another counter between the utility counter and the delivery system. That action, if not properly planned, can produce delays and it is necessary to have specialized staff per each kind of parameter and cut the distribution for an extended period of 2 hours.

Figure 2: Counter at the Genoa pilot that does not support telemetry – photo from the technical visit

Figure 3: Gas counter from Zaragoza pilot with the telemetry device installed (example of counter that support telemetry)

Figure 4: Example of installation of new counters between utility counters and the delivery system in Zaragoza Pilot

Figure 5: Example of the installation of one accessory in order to make the counter available to support telemetry – Zaragoza pilot

Although each installation team will have its own protocols, approach, and methodology, best practices (or one approach) is as follows:

- Establish the communication infrastructure
  - Pinpoint access points
  - Run Cables
  - Install devices
- Install hardware outside of the dwellings
  - Cutting power
  - Disconnecting and reconnecting (device installation)
  - Connectivity test (communication)
- Install hardware inside of the dwellings
  - Contact sensors – what to do and where to place
  - Temperature sensors – where to place
  - Electrical sensors (as appropriate) with board installation (as appropriate)
  - Connectivity test (communication)
- Weather station
- Gas Sensors
- Water Sensors

4.3 System Verification

After all the installation activities are complete, the installers typically use proprietary software to verify if all devices and tags communicate with the data logger. The software gives to the installer different kinds of errors in order to implement corrective actions, such as: change the data logger, put another repeater or change the device.

Once this control action has been performed, the installer needs to communicate with the support team of the remote data base (if used) to verify if the data is being received in the intended manner. It could be set up at which rate the data logger communicates with the remote server and which rate it collects the data. In the case of the pilots, the ISA data logger, by default, communicates with the remote server once per hour and collect each 15 minutes. However, it is possible to force a communication to make sure that all communication is working, avoiding to spend too much time. It is also important that if the internet network fails for some reason that the data logger saves the data and send it in the next communication. Indeed, in case of network instability is possible to lose the communication and is necessary to implement corrective actions. Lastly, when possible it is advantageous to give accessibility to the data logger and the embedded modem from outside. For instance, in the Zaragoza pilot the modem allows the support staff access from outside, making it easier detect faults and make corrective action remotely.

Figure 6: Verification in Genoa Pilot using the software connected to the data logger.

4.4 Closure Communication or Briefing

It is a best practice to formally conclude installation activities. This can occur in a dedicated meeting/briefing, can be supported by a flyer or handout, or can be made part of awareness and training activities. The intent is to make clear:

- Review of what has been done
- Actions left open
- Next steps – when and where awareness and training activities will take place
- Where to get help
- Where necessary: get signed a form of acknowledgment of receipt of equipment or permissions if not already obtained for any reason

As with the rest of implementation activities, the goal is to make sure that each milestone and interaction with the end user is professional, supportive, and a positive experience.

5. Awareness & Training Activities and Materials

Awareness and training activities need to be set up to make aware, inspire, excite, and motivate the end users (tenants and building managers) towards the understanding of energy efficacy measures and the adoption of energy efficiency behaviors. To this aim, awareness activities and training materials are key elements to deploy the knowledge on energy behaviors and make the end users aware of which solutions/activities/efforts are worth to be pursued. Through effective training activities supported by clear materials, end users will develop their own energy saving experience and save more energy (as opposed to without such awareness and training). Moreover such measures reinforce a sense of community and historical data (temperature and consumption) provides a scientific argument for retrofitting interventions to restore an acceptable comfort inside their dwellings.

Within the E3SoHo project, the awareness and training of tenants is part of WP4 (Pilot Implementation) and in particular of task 4.3 (Awareness and Training). Deliverable D4.3 "Deployment of the awareness and training plan" provides training material developed within the framework of the project and how training sections were structured in order to satisfy the requirements of tenants.

Within the framework of the present deliverable 6.2, a summary of key points strictly connected to the implementation phase are reported.

In the following, the awareness and training have been structured within two main phases respectively the pre-monitoring and the post-monitoring one (the intersection of which are installation activities). The key points reported in the next chapters highlight the first sets (before installation) of training while mention more qualitatively the second sets (after installation) of trainings activities. Training aspects related to data analysis will be reported in the next deliverable in WP6, D6.3 "Methodology for Monitoring."

5.1 Activities

All activities leading up to implementation should support the training and awareness goals of the energy efficiency retrofit. Every opportunity should be taken to work with tenants and building managers to let them know of opportunities to conduct more efficient behaviours towards a reduction of energy consortium. It is important to let them understand that this issue is crucial and that their behaviour, supported by the information we can give them, is the way to get smarter in energy consumption.

Moreover tenants are our students, clients, army, or congregation (the correct word is difficult to find) – it is they who must carry out the energy efficient behaviours that will contribute to Europe achieving its energy reduction targets. To do this, they need to see the outcomes of the ICT technologies implemented at the pilots as a way to gather better and more precise information on the status of their dwelling and the functionalities and behaviours which can increase/decrease energy consumption. ICT tools need to become for them the key elements to enable investigation on the energy performance of their dwellings as well as to be stronger, by means of historical data availability, in making arguments which support the need for implementing behaviour changes.

5.1.1 Pre and During Installation Activities

- Conduct of Tenant Surveys: Typically, surveys are conducted to gain information about the behaviours and technical situation within dwellings. It is possible to structure and conduct such surveys so that they are also informative and educational to the persons taking them
- Technical visits: During technical visits tenants are typically curious and want to interact with the designers and stakeholders involved in the ICT solution design. Such opportunities should be taken to interact with the tenants (and all stakeholders) in a positive way about the program and its intent.
- Program Group Briefings: It is likely that several group meetings will be conducted before installation activities that provide the program intent, showcase the technologies, and introduce the stakeholders to energy efficiency in general and to the project specific solutions. Such briefings should be made as synergistic as possible with pre and post installation activities to include permissions, surveys, handouts, scheduling and other training materials in order to continue to reinforce and strengthen project objectives.
- Interaction during installation activities: Tenants will be curious. They will pass in the halls, ask questions, and want to learn about what is happening (and offer their suggestions). Such occasions should be treated as opportunities and increase awareness of the sensors installation, why their location has been chosen, why installing sensors to control openings, why temperature sensors, and so on. Information can be given regarding communications issues, data availability and visualization. One can also reinforce that no risks are associated to the devices installed inside their dwellings and what to do if there are problems.
- Tablet Training: If tablets are utilised, it can be expected that end users might be unfamiliar with, afraid of, and excited by this new technology. The tablet is the tool to make the tenants aware in real-time of the comfort, temperature, humidity and consumptions inside their dwellings. It offers the opportunity to let the tenants observe by themselves what is happening and to take appropriate actions and efforts to modify and possibly improve their energy behaviours. Moreover the tablet by enabling the conversion of consumption in costs makes them really aware and let them verify this in real-time of how virtuous energy behaviour may influence on their daily and long-period costs. Because it is a powerful (and likely new) technology, pre and post training on the tablet is likely required. Clear materials should be developed to support the tablet.

Moreover, the tablet (in its design) should be simple, intuitive, and easy to use.

5.1.2 Post Installation Activities

- Support training: Users should have available to them resources they can refer to after installation activities have finished. These can take a variety of forms (website, tablet functions reinforcement, training seminars, help centre, FAQs) and should reinforce and encourage continued familiarisation and use of the system.
- Training on tenant energy profiles (individual feedback): typically this will be done by conducting one-on-one sessions to provide individual feedback to the tenants to answer their questions and help them understand their individual results. Although individual training, this can also occur in a group setting with general observations about how to understand individual results and question and answer sessions.
- Training on building energy profiles (collective feedback): to reinforce community involvement, to analyse building level results, and to reinforce program objectives, global level saving information should be aggregated and shared with the dwellings and building managers. This can occur in a variety of ways to include group briefings, information on the website, brochures, handouts, etc.

To be prepared for all types of activities, a range of supporting materials can and should be developed. Several are outlined in the following section.

5.2 Supporting Materials

Awareness and Training Activities require clear, simple, and informative materials that support the progress steps of the energy efficiency retrofit. The following materials provide some examples.

- Information Flyer: The program might first be introduced through a community bulletin or document distributed in mail boxes and pined in hall, elevators and stairs to introduce program goals and to begin the creation of a common understanding.
- Initial Questionnaire: this is a survey to begin proving the technological solution designer information about the facility and common energy behaviours of the tenants. At the same time however, this survey can be used to provide information to the tenants and to have them reflect on habits and behaviours.
- Brochure: Brochures typically provide program level information about the project aim and objectives across the pilot's end users and the pilot activities phases. Descriptions of the equipment to be utilised are also often included.

- Program Flyer and Overview Document: These are documents and training materials to make the end users aware of the functionalities and intent of the system installed at their pilots. The main characteristics of the devices, the sensors installation plan, the communication issues and the monitoring aspects on the installation are well identified and defined in these documents. It is worth nothing that the system functionalities and intent should be disseminated in a very clear and systematic way by providing the end users with a minimum set of required information to make them more involved in the planned and envisioned activities.
- User Guidelines: Similar to the instruction manual for a TV or camera, user guidelines should be provided for individual devices (as appropriate) and for the integrated system. These can be consolidated in one large document (system level), or be composed of device and functionality documents. Often this will depend on the technological system (e.g. one system provider with an integrated system vs. the combination of equipment from different service providers).
- Technical Data Sheets: These are the data sheets of the components/devices installed on the pilots. They comprise the sensors installed for information collecting and monitoring data availability and the dashboard (tables) for data visualization and for monitoring control.
- Presentations: Presentations support the individual and group training sessions and can also be utilised for one-on-one interaction as appropriate.

5.3 Awareness & Training in E3SoHo

Awareness and Training began with a community presentation and the solicitation of volunteers for program participation. These volunteers took surveys and interaction began with the solution designers. Presentations, surveys, and a program brochure supported these initial activities.

Program overview documents were later provided to tenants during a day meeting where project staff involved was at disposal of tenant’s questions and doubts or concerns that may arise during the installation phase.

These documents included the following sections:

- Brief introduction to E3SoHo project describing general aims and the meaning of being part of the pilot.
- Description and presentation of the main partners that will be actively involved within the field of each specific pilot.
- Description of the procedures applied and actions performed up to the installation phase in the specific pilot

- Description of the sensors and meters applied: their general technical characteristic and how they collect, and transfer data from the single dwelling to the general server for elaboration
- Description of risks and maintenance of devices
- Main contacts for any anomaly that could be noticed or information they may be needed.

During and before installation phase tenants have been supported by the project team on different topics such as:

- How sensors could be installed;
- How they look like
- Which parameters they measure
- Examples of measurements and applications

To cite a few.

As the project progresses into the monitoring phase, end users seminars will be scheduled along several weeks after the full implementation of ICT system. These training courses will be specifically designed for end users, heightening their awareness in areas related to the rational use of energy at a domestic level and how to operate the monitoring terminal to be installed in their homes. Support will also be available through a website that can be reached through the dashboard tablet devices. Training topics will include:

- automatic monitoring of consumption
- analysis and presentation of consumption data for access by tenants via Internet or other methods
- self-assessment scheme to assess the success of residents of a housing unit in reducing energy consumptions
- improvement of heating controls and feedback to users of heating settings
- Frequently Asked Questions
- Troubleshooting

Special emphasis has been placed on tablet training because this device is the user interface for the integrated system. Training has included what the tablet (dashboard) can do, how to use it, how to log in, and how to view, observe, and navigate through their energy consumption results located on the ISA server.
It is worth noting that all training materials should be clear enough to be utilised by persons familiar and not familiar with ICT and energy efficiency applications. The dashboard is a good example. If a tablet is used, it is easy to get lost in the

variety of functionalities, capabilities, and pre-loaded software. In some cases, it may be better to block or remove some of these "distractors" (such as the games section) and create a customised user manual or supplement that focuses on what the tenants must do with the device.

Technical data sheets provided to tenants have included those for:

- Weather station
- Energy Meter – iMeter Din Rail
- Current Intensity Transformer (Electricity consumption)
- Net Meter (Gas and water consumptions)
- iPoint – Temperature and Humidity (Comfort Parameters)
- iMeter Box (Data logger)
- Communication infrastructure
- Heating sensors
- Light intensity sensors
- Hot water sensors
- Temperature sensors
- The user interface dashboard (tablet)

6. INDIVIDUAL CASE STUDY

In order to allow to D6.2 Methodology for implementation to be a stand-alone document in this section the pilots are presented as individual case studies gathering for each the implementation specific aspects that have been considered and settled up.

For each case study we will report in the following sections the characterization in term of:

Figure 7: Section described for each individual case study

6.1 ZARAGOZA

6.1.1 Key partners

- **Owners of the building and dwellings:** Zaragoza Vivienda. Zaragoza Vivienda is partner of E3SoHo project and is a public company of the city of Zaragoza in charge of the planning, construction and management of social housing developments in the city. It is therefore the stakeholder in charge of the validation of the ICT solution blueprint prior to its deployment in the building, and of its assessment during the monitoring phase with respect to potential replication in other social housing buildings and exploitation of the solution after the end of the project. Besides, its staff includes social workers who have a key role as intermediaries between the tenants and the technical stakeholders, and for carrying out the training activities.
- **Tenants:** The ICT solution is deployed in 16 dwellings of the Zaragoza pilot site. Although they are rented dwellings, and therefore the ultimate decision for installing the ICT solution belongs to Zaragoza Vivienda, it is clear that it cannot be deployed against the will of the tenants, because without their involvement a solution for energy efficiency awareness and training does not make any sense. Therefore it is essential to get written consent from all tenants prior to any installation works, and make sure they are aware of how the installation will affect their dwellings and of which involvement is expected from them once the solution is installed.

- **Energy suppliers:** the Zaragoza pilot site targets the measurement of all energy consumptions: electricity, gas for hot water and heating, as well as cold water. It is therefore essential to contact all the utilities and other stakeholders involved in counters management and reading, in order to understand from the beginning which permissions are needed and any other constraints that have to be taken into account for the installation. The utilities and other energy stakeholders involved in Zaragoza are:
  - **Electricity utility:** the DSO operating in Zaragoza is Endesa, although each tenant can choose that a different company sells them the electricity. However, it has been observed that most of the tenants have also Endesa as energy retailer. Each tenant has its own general electricity meter in a common area in the ground floor of the building.

    At the beginning of the project there were counters of different types, most of them with no telemetry, therefore it was clear that the approach of trying to make use of a pre-existent smart metering infrastructure was not possible in Zaragoza. Furthermore, even if there had been such infrastructure, it would have probably been very difficult to get access to the data collected by the utility, without having it within the project, therefore the consortium decided to install its own smart meters connected to the electricity counters. These smart meters are non-intrusive, because they use current transformers around the wiring to get indirect measurement of the electricity consumption.

    Even doing so, it is necessary to interact with the electricity utility because the installation of the smart meters requires accessing cabling protected by seals. Therefore the utility must give permission for breaking those seals, and then check that the installation done does not falsify the counters' measurements.

  - **Water utility:** the water utility operating in Zaragoza is "Aquagest". The situation is similar to the one of the electricity counters: individual counters for each tenant in a common area in the ground floor, with no smart metering infrastructure, and the most convenient way to get the measurements was to install smart meters connected to the existing counters. However, these counters had no pulse output the smart meters could be connected to, and therefore there was a need to upgrade the counters with others with the required output. Therefore interaction with the water utility is needed in order to get permission for the counters upgrade. Such permission was not granted and therefore the consortium had to keep the old installation and deploy the new counters just next to the ones from the utility.

This solution is not of course the best option for replication, as it implies the use of redundant counters. However, it was the only one feasible in the framework of E3SoHo project, and it is a showcase of how the involvement of the utilities (or the lack of it) has strong influence on the technical choices that must be made during the deployment phase.

- **Gas utility:** the gas utility operating in Zaragoza is "Gas Natural". In this case there is a single counter for the whole building in the ground floor common areas, and Zaragoza Vivienda pays the bill. This cost is then distributed among tenants through the heating and hot water bills, as explained in the service suppliers section below.

  In this case no interaction with the utility was needed, because the existing counter had pulse output and therefore the installation of a smart meter was straightforward. However, it should be taken into account that in other buildings the situation can be different, and problems likes the ones described for the water counters may arise.

- **Service suppliers:** In this group we may consider suppliers of communication services, energy services, or other kind of services which might be relevant for the solution deployment.

In the case of Zaragoza pilot site, there is no relevant communication services suppliers to consider, as the consortium deployed its own communications network, using mobile broadband Internet access for communication with remote servers. So it was only needed to check that there was enough coverage in the place where the router was to be installed, and no special interaction with the service provider (in this case Vodafone) was required.

Regarding the energy services suppliers, we may consider "Gómez Contadores", the company which is in charge of the metering of the individual heating and hot water consumptions of each tenant. As explained previously, the gas consumption of the whole building is paid by Zaragoza Vivienda. There is a central boiler for heating and hot water production, and then the costs are split among tenants by the individual counters installed in the common areas of each floor.

Gómez Contadores takes care therefore of the provision and maintenance of the metering installation, and makes the readings of consumptions.

These data are given to Zaragoza Vivienda, which in turn issues the corresponding invoices for the tenants. It should be noted that many of the heating and hot water counters installed in the building could support telemetry, nevertheless Gómez Contadores takes manual readings.

The heating counters needed a special adaptation (installation of output board) in order to be able to connect the smart meters to them. Therefore interaction with Gómez Contadores was needed as they had to authorize this adaptation. Furthermore, some heating and hot water counters had to be upgraded because they were of a different model, and Gómez Contadores supplied these new counters according to consortium specifications.

Thus the installation of the smart meters for hot water and heating counters is a showcase of a fruitful collaboration with energy service suppliers, which allowed taking as much advantage as possible from the existing infrastructure.

- **Stakeholders within the consortium:** in addition to Zaragoza Vivienda (already mentioned as building and dwellings owner), there are two consortium members directly involved in pilot deployment activities: ACCIONA and ISA.

ACCIONA role is the global coordination of all the activities performed in the pilot: requirements analysis, solution design, baseline analysis, solution deployment and solution monitoring. With respect to solution deployment, ACCIONA takes the lead for interfacing the rest of stakeholders, scheduling all the activities, and validating the working status of the solution deployed.

ISA is the main technological provider, and is responsible for the detailed design of the ICT blueprint, the provision of its own smart metering, the selection of complementary devices from other vendors, and the supply of its software for data communication, processing, and interfaces for the end users.

Furthermore, there is an additional stakeholder of the consortium which was not directly involved in the implementation process: Nobatek. This research center provides energy consultancy services in order to assess the energy savings achieved through the use of the ICT solution, so even if they take no direct part in the installation, they need to be aware of what has been implemented and know in detail the structure of the data that will be obtained through the ICT solution.

In parallel to the energy savings assessment, another stakeholder in the consortium, CSTB, performs a sociological analysis in order to analyze the acceptance of the ICT solution by the rest of stakeholders, with special focus on the customers (tenants and building owners). This kind of service may not be necessary in future replications in other buildings, once that the solution is found reasonably satisfactory for all stakeholders. Nevertheless, if any further substantial modification is made, or new important functionalities are implemented, it should be analyzed whether an additional sociological analysis of the acceptance of the new version of the solution is needed.

- **Other stakeholders outside the consortium:** there is an additional stakeholder that plays a key role in the solution deployment, which is the company responsible for the maintenance of the building. In the case of Zaragoza pilot this role is assumed by "Eulen", which has a framework contract with Zaragoza Vivienda for the maintenance of the different buildings owned by the latter. The maintenance company is the one with the best knowledge of the existing installations in the building, and will normally have the necessary skills to perform some complementary tasks of the installation which the technical supplier of the ICT solution may not have (e.g. works which need dealing with the water pipes of the building). The solution deployment process must therefore take into account which company is in charge of the building maintenance, keep contacts with them to discuss the different installation steps, and clarify how the costs incurred by them will be paid, e.g. costs assumed by the building owner through a previous framework contract (as is the case of Zaragoza Vivienda with Eulen), or by an specific subcontract of their services during the installation period.

6.1.2 Key Activities

As explained throughout the deliverable, the key deployment activities performed in the pilot sites are classified in installation planning, installation implementation, and awareness & training.

6.1.2.1 **Installation planning:**

This planning process in Zaragoza pilot site has comprised the following aspects:

- *Obtaining permissions:*
  - ***Electricity utility (Endesa):*** Obtain permission to open protected boards for installation of electricity smart meters from ISA. After the installation, scheduling of a visit to check the installation done and verify that no improper modifications of the installation have been done.
  - ***Water utility (Gas Natural):*** Obtain permission to replace old water counters with new model equipped with pulse output. This task was not successful, and the new counters had to be installed next to the old ones.

    - ***Hot water and heating metering company (Gómez Contadores):*** Obtain permission to upgrade heating counters with a pulse output board. Agree on the upgrade of some of the heating and hot water counters from other vendors with no adequate output.

  - ***Maintenance company (Eulen):*** Agree on the framework of collaboration during the installation process (taking advantage of the existing contract with Zaragoza Vivienda). Discuss about the different installation aspects and how they can affect the existing installations in the building.

  - ***Tenants:*** Get from tenants signed statement of acceptance of the installation planned in their buildings and access to their consumption data which will be measured.

- *Scheduling the installation:* The scheduling of the installation of Zaragoza pilot site involved the following main actions:

  - Allocation of first weeks of deployment, combining availability of the consortium stakeholders (Zaragoza Vivienda, ISA and Acciona) together with the building maintenance company. Ensure access to all the common areas (electricity counters room, water counters room, communication cabinets and so on).

  - Prior to the first week of installation, ensure the necessary transmission of information to the tenants. Access to the different dwellings is agreed by phone calls between Zaragoza Vivienda and each tenant. Announce in time the planned interruption of services (e.g. electricity during the installation of electric smart meters) which can affect the tenants.

- *Provision and pre-configuration of equipment:* Most of the equipment and materials used in the Zaragoza installation was provisioned and transported directly by ISA as technical provider, and by ACCIONA for part of the equipment, such as the tablets that were used as dashboard for the tenants. Local premises of the building owner (Zaragoza Vivienda) were also used for the storage of some components. This last option is in fact a very useful one once the installation is completed, for the storage of spare components necessary for the deployment of the maintenance plan. Pre-configuration of equipment was a key factor for time saving during the installation, this included for example the configuration of networking equipment (router, wireless access points), telemetry equipment, or the installation of the software in the tablets.

6.1.2.2 **Installation implementation:**

The installation implementation in Zaragoza pilot site encompassed the following main phases:

- Wired communications network deployment
- Installation of electricity smart metering board in counters common room

Figure 8: Zaragoza electricity smart meters installed in counters room

- Installation of electricity smart metering board for partial circuits within the dwellings selected for that

Figure 9: Zaragoza smart meters for partial consumptions monitoring

- Deployment of sensors within the dwellings: temperature/humidity sensors, and window sensors.

Figure 10: Window sensors installed in Zaragoza

- Deployment of sensors in common areas: temperature/humidity

Figure 11: Temperature/Humidity sensor installed in Zaragoza common area

- Installation of new cold water counters and of the smart meters connected to them.

Figure 12: Cold water smart meters in Zaragoza

- Installation of smart meter connected to the general gas counter of the building.
- Replacement of the few hot water and heating counters which were different from the rest. Upgrade of the hot water and heating counters with output board, and connection of smart meters to them.
- Installation of weather station in the building roof

Figure 13: Weather station on the roof of Zaragoza building

- Installation of enthalpy meter for solar thermal generation monitoring

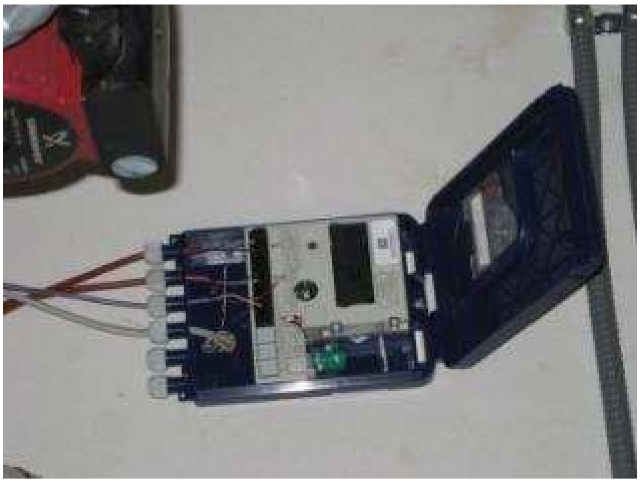


Figure 14: Installation of solar thermal generation monitoring system

- Installation of repeaters in common areas for ensuring communication with all the sensors and smart meters deployed.
- Installation of wireless network equipment
- Deployment of tenants' dashboards (tablets) in their dwellings.

Figure 15: tablet deployed in one dwelling in Zaragoza pilot

6.1.2.3 **Awareness and training:**

Awareness and training activities required the preparation of several supporting materials during the pilot implementation, mainly:

- o Information brochures about the project (to start contact with tenants)
- o Information brochure describing practical aspects related to the installation (and especially the part of the installation to be carried out within the dwellings)
- o Direct feedback to tenants about the installation done at their home, and how they have to deal with it.

Figure 16: individual training session carried out in Zaragoza pilot

- o Forms to get signature from tenants to confirm the devices they have been provided with after the installation.
- o User manuals for software interface.

  - Guidelines about the project objectives, project team tenants can contact with, and initial guide for improvement of behaviours towards energy efficiency.

6.1.3 Key Resources

The implementation of Zaragoza pilot requires as in other pilot a combination of human resources and technical means.

Regarding the human resources, the team involved in the deployment phase consisted mainly of:

- Technical installers and experts from the main technology supplier ISA: in most of the installation activities a team of two technicians from ISA was involved. Once the deployment was almost finished, the team was frequently reduced to one person, in charge for completing the last steps for getting the installation running, and checking its working status. These technicians in the field were remotely assisted also by others in ISA premises for completing configuration of equipment.
- Installation coordinator from ACCIONA: normally this company involved one person to work in the coordination and validation in the field of all the installation works. In some of the most critical phases, such as the deployment of the dashboards, or of the wireless communication network, the team was increased to two persons.
- Supporting team from building owner Zaragoza Vivienda: the supporting team from Zaragoza Vivienda was normally composed of up to two social workers responsible for the relationship with the tenants with respect to access to their premises, transmission of information, and training activities. They were responsible as well for coordination with internal technical staff, getting authorizations and so on.
- Other human resources: occasional involvement of Eulen as company in charge of building management, and of Gomez Contadores for support to the hot water and heating counters upgrade.

Regarding the technical means needed, they can be summarized in:

- Sensors per dwelling: 1 temperature/humidity sensor, 3-4 window sensors for monitoring living room terrace and 1 bedroom.
- Sensors per common area (per floor): 1 temperature/humidity sensor
- Smart meters per dwelling: 1 meter for electricity, 1 meter for heating and hot water, and 1 meter for cold water. However, smart meters can be shared with other dwellings, thus reducing the total number required. For instance the electricity smart meter can measure up to three general consumptions from dwellings. In the case of partial circuit monitoring, two additional smart meters are needed within the dwelling for implementing this function (measuring up to 6 different circuits).
- 1 tablet per dwelling.

- Other means shared by all dwellings: board for the deployment of the electricity smart meters, repeaters for ensuring communication with all smart meters, gas smart meter, weather station, and meter for solar generation monitoring. Remote servers for hosting iEnergy and sDisplay services.

6.1.4 Value propositions

For the analysis of the added value provided by the ICT solution deployed at Zaragoza pilot site, two types of customers should be considered: tenants and building owner.

- **Tenants:** they are provided with a solution within their dwellings which can help them to:
  - Be aware of their different energy consumptions (electricity, hot water, heating), and of their consumption profiles (per day, per appliance…)
  - Get feedback about the comfort parameters of their dwellings
  - Be provided with specific training for adopting energy efficient behaviours.
  - Get alerted about abnormal energy consumptions they may not be aware of.
  - Identify opportunities to reduce their energy consumption, without compromising comfort, and thus achieve savings in their bills
- **Building owner:** the owner of the pilot site (Zaragoza Vivienda) is provided with a solution in the building that can offer the following added values:
  - Get updated information about global energy consumptions of the building. In the case of Zaragoza building, this is done with gas consumption only, but it could be extended to other parameters, such as electricity consumption in common areas.
  - Get information about the performance of the renewable energy installations of the building. In the case of Zaragoza building, there are solar panels to produce hot water. By comparing the measured gas consumption with the hot water production, the building owner can assess the energy savings and CO2 emissions abatement derived from the use of renewables, and at the same time comparing the real performance of the installation with the theoretical one planned during the building design phase.
  - Get information about comfort parameters of the building. Through the monitoring of temperature and humidity in the common areas, together with the same data measured within the monitored dwellings (provided that the owner is granted the access to these

data by the tenants, as it is the case in Zaragoza), the owner can assess whether the building performance with regard to indoor comfort is according to expected standards.

- Get precise climate data in the building location (through the weather station installed on top of the roof), which can be used either to analyze energy consumptions correlated to these data, or to analyze the indoor comfort parameters of the dwelling.
- Analyze energy consumptions of the monitored dwellings (provided that the owner is granted access to these data by the tenants, as it is the case in Zaragoza), in order to assess the global energy performance of the building, as a decision support tool for evaluating the technical and economic feasibility of refurbishing actions in the building.
- Analyze the global energy savings achieved through the implementation of the ICT solution, in order to assess its replicability in other buildings owned by Zaragoza Vivienda.

6.1.5 Channels

Channels used to reach the different customers and stakeholders are:

- **For tenants:**
  - The main channel is face-to-face interaction with the social workers of Zaragoza Vivienda. For the replication in other buildings with different owners, it should be considered whether this kind of staff is available, and if not, look for alternatives for having this direct channel to the tenants, which has proven the more efficient way to achieve their involvement.
  - Telephone calls to schedule technical visits or training/information sessions.
  - Written material providing information about the project, the equipment installed within the dwellings, solution manuals, and any other training material.
- **For utilities:** the best channel for this is the building owner, although in some cases this communication can be managed also by the technical coordinator of the deployment.
- **For maintenance and energy services suppliers:** also Zaragoza Vivienda, as the stakeholder with the contract with these services companies, is the most adequate channel to get in contact with them and inform them about the deployment activities, although direct contact with the technical coordinator is possible too.

6.1.6 Costs structure

The cost structure of the ICT solution implementation can be divided into the following main components:

- **Personnel, travel and subsistence costs:** costs of the staff needed from different stakeholders, for performing several activities as described in the sections above: installation scheduling, installation implementation, and initial awareness and training campaign. Therefore costs of ICT technicians, installers, social workers, and solution designers should be considered. It should be noted that there is a minimum threshold of personnel costs that are necessary to deploy the main common infrastructure of the solution (e.g. install the communications network, configure the remote server and software for data processing and presentation, etc), which will depend on the complexity and size of the building, and on the other hand there are marginal costs linked to the deployment of the solution within the dwellings, and which will vary with the number of dwellings in which the solution is installed.
- **Equipment and consumables costs:** similarly to the personnel costs, there will be "fixed" equipment and consumables costs needed for deploying the common infrastructure for the building (wiring and networking devices for the communications network, weather station, smart meters for monitoring building total energy consumption and production, etc.), and marginal equipment and consumables costs linked to the number of dwellings in which the solution is installed, as this will impact on the number of smart meters, sensors, repeaters, user interfaces, etc. needed. The number of dwellings will also determine the unitary cost of the installation in one dwelling, because the higher this number, the cheaper the costs of the devices will be. The main equipment and consumable costs to be considered in Zaragoza are listed below:
    - *Communications equipment:* Internet router (one 3G router in Zaragoza, although for replication other types of connection such as ADSL or optic fiber could be considered). Wireless access points for creating WiFi network and provide connectivity to the tenants (in Zaragoza one access point per floor has been installed). Ethernet wiring.
    - *Concentrators:* concentrators from ISA can locally store the measurements of different meters (connected to them either through wireless or wired protocols) and send them to a remote server through Internet connection. 10 concentrators have been installed in Zaragoza pilot site.
    - *Repeaters:* ISA repeaters have been installed in order to guarantee the communication between some wireless sensors and meters with the corresponding concentrator.

- *Weather station:* 1 weather station has been installed on top of the roof of the Zaragoza pilot site.
- *Solar panel monitoring system:* the production of thermal energy (hot water) of the solar panel is monitored through an enthalpy meter which integrates a water counter and two temperature sensors.
- *Electricity smart meters:* one electricity smart meter from ISA can measure up to three different circuits. Therefore in a counter common room each meter can be used for three different tenants, while within the dwellings, two meters can be used to measure up to six partial circuits, which is the typical number that we can find in a dwelling.
- *Gas, cold water, heating and hot water meters:* wireless smart meters from ISA are connected to the pulse output of the corresponding counter.
- *Counter upgrade:* in the case of Zaragoza it was necessary to upgrade the cold water counters, to install an adaptation board in the heating counters, and to upgrade part of the heating and hot water counters.
- *Temperature/humidity sensors:* this wireless sensor from ISA can measure temperature and humidity simultaneously. In Zaragoza one sensor has been installed within each dwelling, plus one sensor in each common area of each floor.
- *Window sensors:* between 3 and 4 (depending on the type of dwelling) wireless sensors from ISA have been deployed in the living room and in one bedroom.
- *User interface:* 1 tablet with Android operating system and capacitive touchscreen deployed within each dwelling.
- *Server:* 1 remote server hosting the data communication and processing platform, and another remote server for hosting the user interface software. The same servers can be used to give service to several buildings.
- *Licensing costs:* although ISA provides this software within the project free of charge, for the replication in other buildings the licensing costs of the data processing platform and of the user interface software should be considered.

6.1.7 Lessons learned

The lessons learned within the pilot from a **technical point of view** are linked to factors such as:

- The need to try to take advantage of the pipes of the building to get the cabling without causing much impact.

- The need to check all the counters to verify if they have pulse outputs (M-Bus compatible). If they don't have any pulse output, they have to be replaced by others which have, or be adapted For instance, the heating and hot water counters needed to be adapted with an output card in order to have a pulse output. It was the case that the counters were a discontinued product from Kamstrup manufacturer, so it was necessary to contact them in order to have the adaptation output cards specifically for this project. Therefore this process must be planned in advance.

- It was needed to recollect documentation of the installation project of gas, water and electricity.

- The absence of Internet inside the building was a difficult on the implementation of the monitoring system. An entire communications network had to be designed and deployed in order to enable data transmission.

- TV antenna in the roof interfered with the weather station communication.

- It is not always possible to replace old counters which are not compatible with the smart meters, because the utility will not give the authorization. Therefore, although the installation process associated might be more complex, it can be advisable to install new counters next to the old ones, instead of making a replacement, thus it will not be necessary to get authorization from the utility.

From **a practical point of view** the main lessons learned are linked to:

- Get all permissions in advance from the utilities for any modification that might be necessary to do in the counters installation.

- Make sure that electricity cuts do not affect the appliances of the tenants, e.g. tenants must be asked to switch off the washing machine before cutting electricity.

- Provide support to the tenants during and after the installation to solve any technical problem that might have been originated by the installation process (e.g. breakdown of an appliance due to an electricity cut).

- Finally, it is necessary to have permanent contact with the company in charge of the maintenance of the building (usually a subcontract of the building owner) and to inform it about all the details and progress of the installation process.

6.2 Warsaw

The deployment activities in Warsaw pilot site aimed to monitor the energy consumptions (electricity, hot water, heating), comfort parameters (temperature, lighting levels) and behavioural parameters (contact sensors for monitoring opening/closing of windows, presence detectors) and provide a dashboard to the tenants in 16 dwellings. Furthermore, weather data are also monitored. A communications network has also been deployed in order to enable local data storage, remote data backup storage, as well as data migration to iEnergy OS Platform. Dashboards of the tenants access the Internet through wireless network set up in a building.

Short description and specification of deployment building:

- The building is a recent construction, with five level occupied by offices at floor
- level and dwellings in the other levels – table 1.
- The building is alimented with gas and electricity, common counters being located at floor level. The weather station is installed on the roof of the building.

  The building is heated through a collective gas boiler (recent system) and hot water, for heating and for DHW separately, is distributed to the dwelling individually. For each dwelling, pipes are equipped with individual energy counters measuring separately heat consumption and DWH consumption. Hot water is distributed into the dwellings through radiators equipped with manual thermostat.

6.2.1 Key partners

- Owners of the dwellings: City of Warsaw. City of Warsaw is a partner of E3Soho project and is a public company of the city of Warsaw. Responsibilities of the City of Warsaw are all matters of public issues of local interest (planning, construction and management, infrastructure, issues regarding social housing developments in the city etc.). Therefore, the City of Warsaw is interested in implementing ICT solutions in social housing, which will increase the awareness of the tenants of saving media consumption and consequently could saves money. In fact, both the City of Warsaw and tenants should care about savings money. Moreover the City of Warsaw is in charge of the validation of the project in demonstration building with planning to expand the potential of the ICT solutions to other social housing buildings.
  The City of Warsaw has social workers who have a key role as intermediaries between the tenants and the technical stakeholders, and for carrying out the training activities.

- Tenants - The ICT solution is deployed in 16 dwellings of the Warsaw pilot site. The same situation as in Zaragoza: "Although they are rented dwellings, and therefore the ultimate decision for installing the ICT solution belongs to ZGN Ursus, it is clear that it cannot be deployed against the will of the tenants, because without their involvement a solution for energy efficiency awareness and training does not make any sense. Therefore it is essential to get written consent from all tenants prior to any installation works, and make sure they are aware of how the installation will affect their dwellings and of which involvement is expected from them once the solution is installed."
- Company of property management (ZGN URSUS),
- Energy suppliers (There are different suppliers of measured media. Therefore is essential to contact all the utilities and other stakeholders involved in counters management and reading, in order to understand from the beginning which permissions are needed and any other constraints that have to be taken into account for the installation.)
- Installation company (Mostostal),
- Services company (SABUR or other equipment provider),
- Within the consortium:
  - ISEP - Warsaw University of Technology (design system, application creator, consultation regarding consumption energy)
  - Mostostal Warszawa S.A. (responsible for the deployment, training activities services for the tenants, application creator),
  - City of Warsaw (responsible for the choice of the pilots, informing about the project, gather opinion about the deployment/project, contact with the tenants),
- Outside the consortium
  - Sabur (ICT supplier, responsible for communication services).

6.2.2 Key Activities

The detailed list of actions performed in the pilot:

6.2.2.1 **Planning installation activities**

The one of aim of the project was selection and testing the E3Soho project for various configurations options of apartments. Choice of apartments depends on:

- Location in the building – site of the world, floor in the building,
- Apartment area,
- Number of tenants in apartment.

Apartments with similar areas are not homogenous (e.g. they have different number of rooms, equipment etc.). Therefore the choice of dwellings and the subsequent selection of appropriate measuring, communication devices was not easy (because of their diversity). Obviously such diversity and various location of the apartments in the building cause increase cost of installation (including all cable infrastructure, devices for ensuring communication etc.). However, this solution / option (diversity of apartments and various location) will allow to verify and execute cost analysis for decentralized system.

Table 1: Selected dwellings to demonstration – location in building.

No	Living area	Usable area	Number of rooms	Floor	Number of persons in the flat	Side of the world	Comments
Staircase I							
1.	19,72	25,27	1	Ground floor	0	NW	uninhabited
2.	21,06	29,24	1		1	NW	A0
3.	31,24	43,14	2		3	SE	B0
4.	30,91	40,23	2		5	SE	
5.	30,91	40,23	2		3	SE	B0
6.	31,24	43,14	2		4	SE	
7.	21,06	29,24	1		1	NW	A0
8.	21,08	25,38	1		2	NW	
9.	20,70	25,00	1	Floor I	1	NW	
10.	20,80	28,98	1		2	NW	
11.	31,34	43,14	2		4	SE	
12.	30,91	40,23	2		3	SE	
13.	30,91	40,23	2		3	SE	
14.	31,34	43,14	2		3	SE	
15.	20,80	28,98	1		2	NW	
16.	20,70	25,00	1		2	NW	
17.	20,28	24,58	1	Floor II	1	NW	A2
18.	20,54	28,72	1		1	NW	A2
19.	31,34	43,14	2		4	SE	
20.	30,91	40,23	2		5	SE	
21.	30,91	40,23	2		3	SE	B2
22.	31,34	43,14	2		3	SE	B2
23.	20,54	28,72	1		3	NW	
24.	20,28	24,58	1		1	NW	
25.	20,08	24,38	1	Floor III	1	NW	A3
26.	20,28	28,46	1		1	NW	A3
27.	31,34	43,14	2		4	SE	B4
28.	30,91	40,23	2		3	SE	B3
29.	30,91	40,23	2		3	SE	B3
30.	31,34	43,14	2		4	SE	B4
31.	20,28	28,46	1		1	NW	A3
32.	20,08	24,38	1		1	NW	A3

Based on the above requirements and the set of assumptions were selected the following sensors for installation:

- Open – close windows sensors,
- Inside temperature sensors,
- Meters for electrical energy consumptions (divided into: plugs and light),
- Meters for hot water,
- Meters for central heating system,
- PIR sensors,
- Inside illumination sensors,
- Weather station.

The sensors were installed (while retaining all of the requirements of the installation of sensors) in that way to avoid:

- disturb residents with daily activities,
- destruction of dwelling,
- changing dwelling design.

To fulfill all requirements the installed sensors are wireless. The communication of data to the data loggers has been set up by using the ZigBee technology. Data loggers, through routers communicate back to the remote server at Sabur.

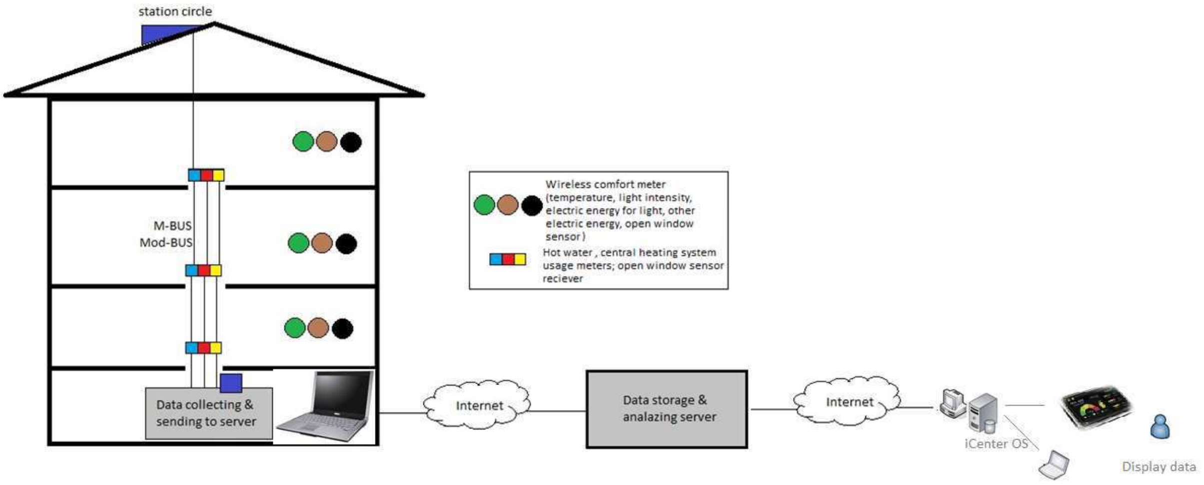


Figure 17: Warsaw installation architecture.

To adapt the design to the on-site conditions and to the best coordinate installation activities, Mostostal, ZGN Ursus, Sabur conducted a final pre-installation that consisted of the following activities and actions:

- Analysis of the existing electrical boards to plan how and where to put the new electrical board with the smart meters for detailed electrical consumption.
- Communication with tenants and building manager to gather information about:
  - Contact person that has to be contacted for the installation in building/dwelling and to be informed in case any difficulties.
  - Address.
  - Building type.
  - General counters floor.
  - Number of people.
  - Dwelling area (m2).
  - Heating system.
  - Internet availability.
- Inform about installation and the impact of it.
- Identify the necessary structural details in order to build the communications network.

6.2.2.2 **Executing the Installation.**

The installation in Warsaw pilot started in April 2011 and finished in June 2011 Below there is description regarding installed devices/elements of the system and pictures made during the installation.

ICT solution for the polish pilot consists of the following parts:

- Control cabinet

Control cabinet has been installed on level -1. It contains Saia-Burgess PCD3.M5540 PLC with input modules and communication modules, base station for energy reading (Techbase ATC-873-S2), base station for temperature sensor and PIR sensors (Produal FLTA) and PC with MySQL database server running. PLC and PC are connected to LAN with Internet access.

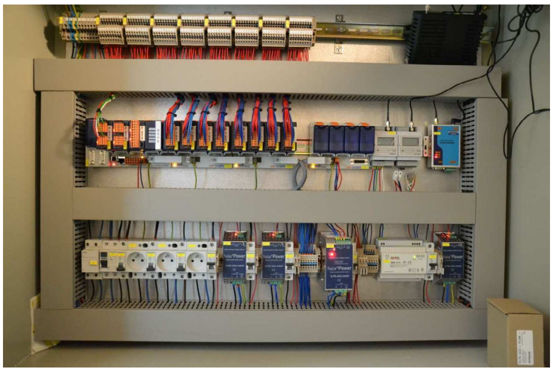


Figure 18: Control cabinet for Warsaw.

- Weather station

Weather station (Elsner Elektronik P03/3-Modbus) has been installed on the roof of the building. It is connected with PLC using double wire. Communication is carried out using Modbus protocol. Weather station provides measurements of temperature, wind strength and brightness.

Figure 19: Weather station.

- Reed switches for windows (open – close windows sensors)

Reed switches (Elmes Electronic CTX4H) have been installed on each window in such way that they detect if the window is open or closed. They communicate wirelessly using 433,92 MHz frequency with base stations (Elmes Electronic CH8H) installed in mains accessible from staircase. Base stations are connected with wire to digital input modules in the PLC. Communication is event based – reed switches send messages to base station only when window has been opened/closed.

Figure 20: Reed switches for windows (open - close windows sensors).

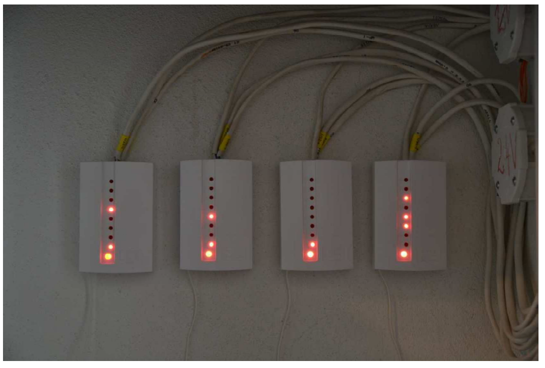


Figure 21: Elmes Electronic CH8H.

- Energy meters

Energy meters (Saia-Burgess ALD1D5F10) with impulse outputs are connected to impulse counters (Saia-Burgess PCD7.H104S). There have been two meters installed per flat – for lighting and for energy sockets. Data from impulse counter is transmitted wirelessly through transparent radiomodems (Techbase ATC-873-S2) using 868 MHz frequency. There is one radiomodem in each flat and one radiomodem connected to the PLC that allows the PLC to access the whole network wirelessly. PLC uses S-Bus protocol to read data from impulse counters.

Figure 22: Energy meters.

- Hot water and heat meters

Hot water (Actaris CF-Max) and heat meters are located in mains They are connected with double wire to the M-Bus module in the PLC. Each main has its own M-Bus line and communication is carried out using M-Bus.

Figure 23: Hot water and heat meters.

- Temperature and PIR sensors

Temperature sensor (Produal TEFL) and PIR sensor (Produal LAFL) with brightness measurement have been installed in each room. They communicate wirelessly using 868,3MHz frequency. There are two subnets – for left and right main. There are two repeaters (Produal FLREP-U) installed on the first floor and two base stations connected to the PLC on two different channels. Communication is carried out using Modbus protocol.

Figure 24: Temperature sensor.

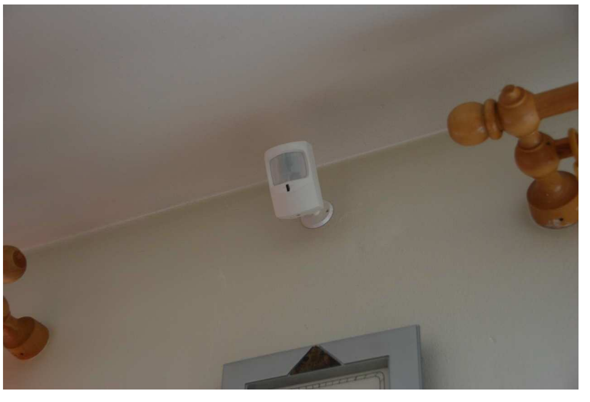


Figure 25: PIR sensor.

- PLC controller and PC server.

PLC communicates with PC via Ethernet using S-Bus protocol. There is an application on the PC installed that acts as S-Bus Slave and Master, allowing two way communication (and initialized by either PC or PLC). This allowed to create flexible and efficient communication, where data from energy, heat, hot water, temperature sensors and weather station is read periodically by PC (every 15 minutes), while using advantages of event communication with other sensors. Information about change of window state, room presence is transmitted instantly by the PLC. The application inserts all data to MySQL database. Backups of the database are created daily. All data is also backed up in CSV files in the PLC.

PLC controller

The block diagram of used PLC control system shows below.

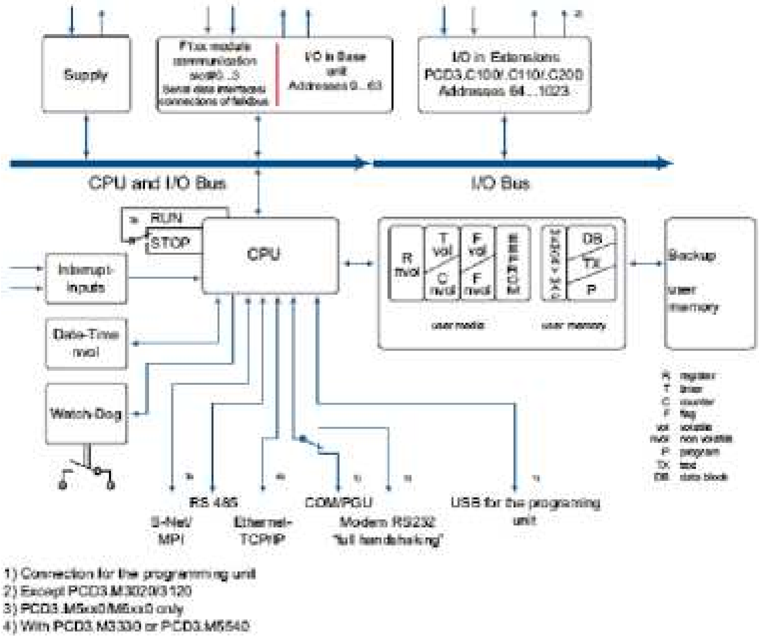


Figure 26: Block diagram of used PLC controller.

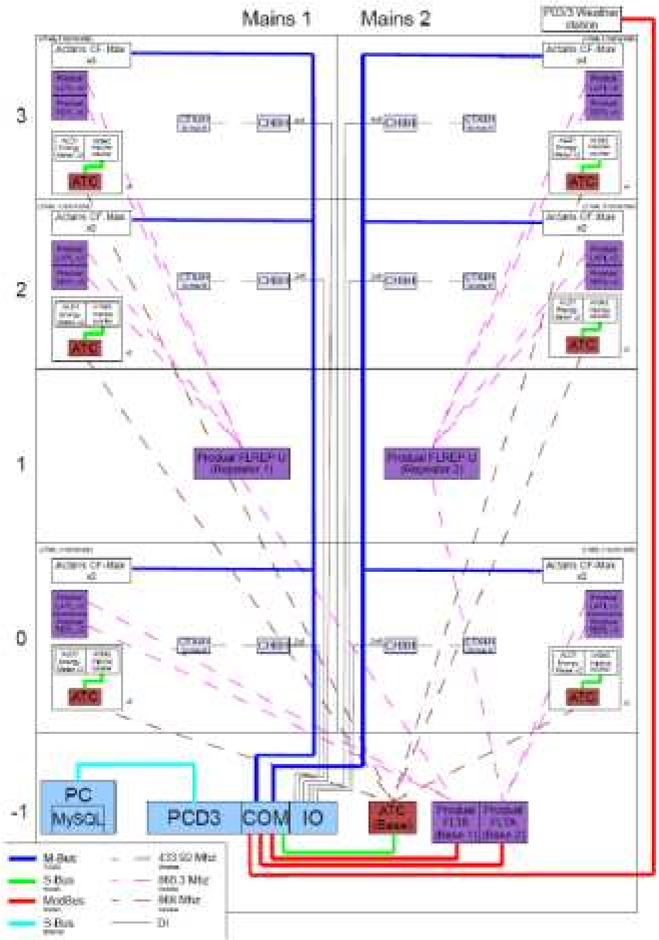


Figure 27: Schematic diagram of system communication.

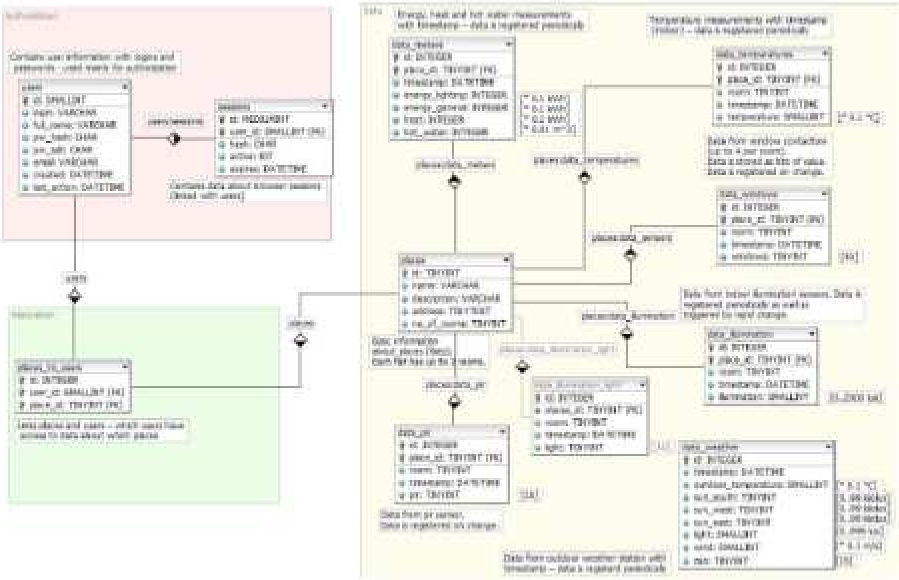


Figure 28: Database structure.

- Dashbord

  For the user interface used in Warsaw pilot site the dashboard device chosen was the Samsung Galaxy Tab "7 with 3G module.

Figure 29: Dashboard for user interface - Samsung Galaxy Tab.

<u>General Specification</u>:

– 2G Network GSM 850 / 900 / 1800 / 1900

– 3G Network HSDPA 900 / 1900 / 2100

– Dimensions 190.1 x 120.5 x 12 mm

– Weight 380 g

– Type TFT capacitive touchscreen, 16M colors

– Size 600 x 1024 pixels, 7.0 inches
– Multitouch Yes
– Protection Corning Gorilla Glass
– Card slot microSD, up to 32GB,
– Internal 16/32 GB storage, 512 MB RAM
– GPRS Yes
– EDGE Yes
– Speed HSDPA, 7.2 Mbps; HSUPA, 5.76 Mbps
– WLAN Wi-Fi 802.11 b/g/n, Wi-Fi hotspot
– Bluetooth Yes, v3.0
– OS Android OS, v2.2 (Froyo)

- User interface: the user interface used in Warsaw pilot site is VAS (Visualization and Alert System). The alternative interface sDisplay is also compatible with the installation and has been tested as proof of concept, but the application given to the tenants has been VAS.

– VAS can be used from any device with Internet connectivity and standard web browser. Tenants were provided with a tablet optimized for the use of VAS.

– In order to make easier the use of VAS, the tablets provided to the tenants were configured so that they can only be used for monitoring media consumption. Other features of the tablet are blocked (surfing the web, etc.). Lock function has been performed using applications: SureLock and SureFox.

Figure 30: Screenshots of VAS user interface

6.2.2.3 **Awareness and training**

After the implementation tenants received:

- Guidelines for tablets.
- General training on how to use VAS user interface and general information on what the project is about
- Customised training through real simulation

6.2.3 Key Resources

Resources were needed for Warsaw implementation in order to:

- Provide the equipment and ICT hardware (sensors, data loggers, cable, tablets).
- Technical installers and experts who physically realized the installation on the pilot –Mostostal.

- Supporting in the configuration of the equipment (by hardware supplier).
- Supporting team/persons from building manager – ZGN URSUS.
- Train people who informed tenants about the project, collected needed information and train tenants on how to use the VAS application.

6.2.4 Value propositions

For the analysis of the added value provided by the ICT solution deployed at Warsaw pilot site, two types of customers should be considered: tenants and building owner/manager.

- **Tenants** (as the main users)
  - Get feedback about their consumption - make them aware of the size, time of the day and type of energy consumption (electricity, hot water, heating etc.).
  - Get feedback about the comfort parameters in their dwellings.
  - Benefit from the training on energy saving behavior.
  - Informed/alarmed about excess energy consumption they may be aware of.
  - Indicate the possibility of reducing energy consumption and thus savings in bills.
- **Building owner/manger**
  - Get updated information about global energy consumptions of the building.
  - Get information about comfort parameters of the building.
  - Get information about the performance of the renewable energy installations of the building.
  - Get precise climate data in the building location by the weather station.
  - Analyze energy consumptions of the monitored dwellings.
  - Analyze the global energy savings achieved through the implementation of the ICT solution, in order to assess its replicability in other buildings.

6.2.5 Channels

Channels used to reach the different customers and stakeholders are:

For tenants:

- Interaction face-to-face – this is the best channel for that group of people. There is possible to discuss/inform about everything, get feedback, opinion etc.
- Telephone calls to inform about schedule technical visits/training sessions etc.
- Written material providing information about the project and application.

For maintenance and energy services suppliers:

- By ZGN URSUS which is the building manager or technical coordinator of the deployment.

For utilities:

- The best channel is the building manager or technical coordinator of the deployment.

6.2.6 Cost structure

- Equipment and consumables costs:

Equipment and consumables costs will not be constant/fixed. They will be depend on size of building, number of dwellings, installed infrastructure in the building (wiring, devices, counters, devices for communications network) and many other. A larger number of dwellings (installed devices there) will reduce the unit cost of installation in the dwelling.

- Personnel costs:

For staff and persons responsible for:

- pre-installation activities (scheduling, choice of installer, equipment, system and application design),
- the installation implementation
- Initial awareness, information and training campaign for tenants.

- Possible savings in the future:

- the development of e-learning module could reduce the efforts for such task.
- already prepared an application - user Interface for tablet.
- already selected and verified installer company.
- already selected equipment which can be repeated and be suitable for other buildings.

6.2.7 Lessons Learned

- It's necessary to check 3G connection and strength of the radio waves. In case of poor signal penetration it's needed to install some repeaters.

- It is necessary to check all the counters to see that they have output pulses (M-Bus compatible). If they don't have any output pulse they have to be replaced by others which have, or adapt them.

- The additional internet connection had to be installed to not reduce the speed of the connection in the office.

- It was necessary in advance inform and prepare tenants for installation process.

6.3 GENOVA

In the following section is reported what was done in the installation phases within the Genova pilot.

6.3.1 Key partners

The key partners that have been involved in the implementation phases can be collected in four main categories that are: owner of dwellings, tenants, energy and services suppliers. Such categories are described in more details hereafter.

Owners of the dwellings: it is necessary to involve the owners of the dwellings since they must know what the project is going to installing in their apartments, for which aims and in parallel they provide authorizations – permissions for installations (see section 3.1.2), general info, plants of the dwellings and even info on profiles of tenants that are living within their dwellings.

- Comune di Genova – Genova Municipality - Partner of E3SoHo Project owner of part of the dwelling and responsible for the allocation of empty social dwellings.
- ARTE that is the regional agency for the construction sector of Genova and is the entity responsible for managing the public constructions and planning the main interventions needed at regional level in term of improvement of public constructions.

Tenants: they must be aware of the initiative aims, solution installed, parameters monitored, contact people in case of need and in parallel they must provide the permission for installation (see section 3.1.3). In Genova 31 householders have been involved.

- Monitoring group composed by 16 dwellings - respective codes are: Apt 1 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10 – 11 – 12 -13 – 14 - 29 - 25 – 115);
- Control group composed by 15 dwellings - respective codes are: Apt 2 – 16 – 103 – 118 – 106 – 108 – 109 – 107 – 117 – 119 – 113 – 114 – 112 – 111 – 116).

Energy suppliers – it is necessary to inform energy suppliers since part of the installation is done in the electricity board owned by them (see section 3.1.1). Within the Genova pilot only the electricity supplier was involved since gas and water consumptions are not monitored.

Services suppliers – are those stakeholders responsible for the overall execution of installation activities, communication of data, energy suppliers and global support:

- Within the consortium

    - ISA - ICT supplier - cable net developer- installation of sensors- repeaters-data logger etc- configurations of devices – data collection platform;
    - ACCIONA - provider of part of the ICT solution in particular the tablets for tenants;
    - D'Appolonia - pilot responsible providing general support services for the other pilot partners and training activities services for the tenants;
    - CSTB- support on implementation and support on social aspects.
  - Outside the consortium
    - Vodafone for the supply of sim cards and mobile communication services;
    - Telind (company in charged by Vodafone for visit in the pilot and assessment of communication network);
    - 4 noks SME for the supplier of smart plugs and repeaters.(this was identified on the market considering the needs of the project)

6.3.2 Key Activities

6.3.2.1 Planning the Installation

<u>Sensor localization and building the communication infrastructure</u>:

Due to the particular configuration of the district and to the fact that dwellings involved within the initiatives are not homogenous (e.g. they have different number of rooms, areas, equipment, and heating system), it was decided to instrument the chosen apartments with:

- Open –close windows sensors;
- Temperature & humidity sensors;
- Meters for electrical energy consumptions.

For the monitoring of electrical consumptions the energy supplier was contacted in order to check their availability and the possibility to proceed avoiding any surprise during the installation. Installation was planned in order to have meters on the general counters and the analysis of the repartition among different uses was planned to be done through the installation within the dwellings through the use of dedicated outlet smart plugs.

The installation plan of the other devices, open –close windows sensors, humidity sensors and temperature sensors, has been defined. The communication of data to the data loggers has been set up by using the Radio Frequency. Data loggers, through routers communicate back to the remote server at ISA. The internet communication of data from the data loggers (on site) to the collecting server (remote) has been provided by means of a 3G HSPA connection which is physically deployed by a SIM Card lodged into the router.. Each data logger collects data from a group of apartments. Because the chosen apartments were spread over various parts of the 400 apartment complex, six different connection points (data loggers) were implemented as reported in the following figure:

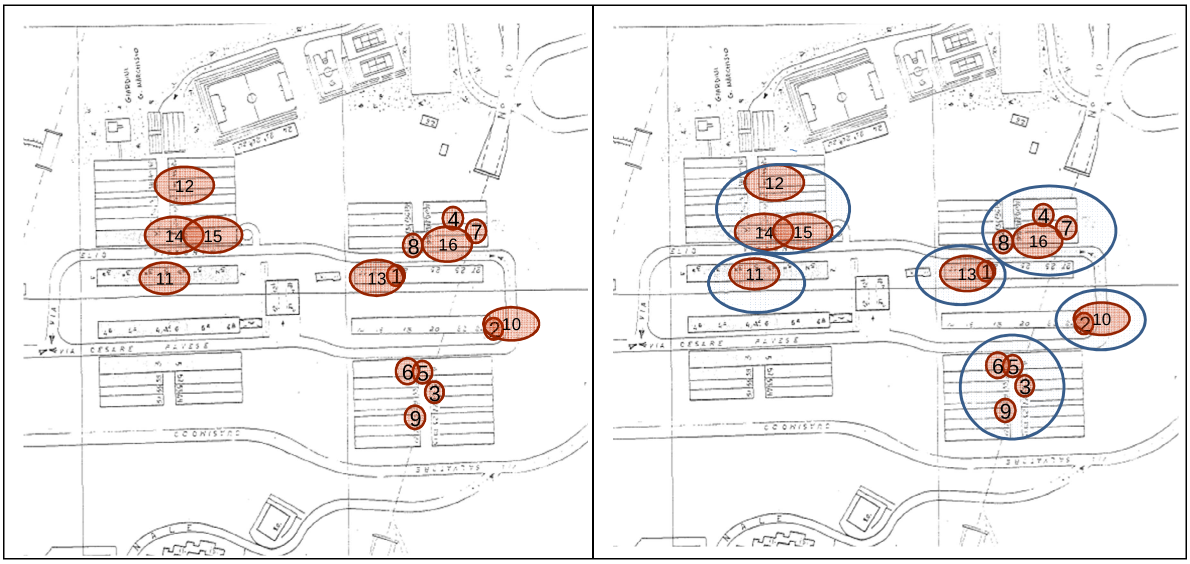


Figure 31: Apts and data logger for the monitoring group

The installation of the meters for gas and water were not possible. The Genoa pilot joined the project in progress and time was not available to change the existing gas meters into a type able to support sub-metering and the permission process for both gas and water was not feasible in time for these utilities. Water also is interesting at this pilot because there is only one meter for the entire complex and water bills are divided based on apartment square meters.

Actions during the final technical visit:

To adapt the design to the on-site conditions and to best coordinate installation activities, DAPP, Comune di Genoa, ISA and CSTB conducted a final pre-installation that consisted of the following activities and actions:

- Analysis of the existing electrical boards to plan how and where to put the new electrical board with the smart meters for detailed electrical consumption.
- Communication with tenants was conducted to
    - gather information related to
        - contact person that has to be contacted for the installation and to be informed in case of electricity cuts
        - Address
        - Building type
        - Total floor of the street number
        - APT floor
        - General counters floor
        - Number of people

        - Heating system (centralized or single unit)
        - Dwelling area (m2)
        - Internet availability
    - Distribute simplified installation brochures
    - Inform tenants of the impact of the installation
- Identify the necessary structural details in order to build the communications network

6.3.2.2 Executing the Installation

The installations in Genoa pilot were conducted during the beginning of October 2011 as reported in the figure below. The first week was needed in order to build the network islands and to install the monitoring systems for the general electrical circuits. ISA, DAPP, and The Comune di Genoa participated in the installation activities.

During the second week, technical installation and configurations have been developed and each dwelling has been provided with temperature, humidity, open/window sensors and energy consumption metering.

	03-Out	04-Out	05-Out	06-Out	07-Out	08-Out	09-Out	10-Out	11-Out	12-Out	13-Out	14-Out
	M	T	W	T	F	S	S	M	T	W	T	F
09:00 -10:00	Travel	To build the network islands and to install the monitoring systems for the general electrical circuits. (This work will be made outside the dwellings and is important to inform the tenants that the electrical distribution will be stopped 10 minutes in this week per dwelling)						Technical procedures and configurations.	Dwelling x	Dwelling x	Technical procedures and configurations.	Travel
10:00 -11:00									Dwelling x	Dwelling x		
11:00-12:00									Dwelling x	Dwelling x		
12:00-13:00									Dwelling x	Dwelling x		
13:00-14:00												
14:00-15:00								Dwelling x	Dwelling x	Technical procedures and configuration		
15:00-16:00								Dwelling x	Dwelling x			
16:00-17:00								Dwelling x	Dwelling x			
17:00-18:00								Dwelling x	Dwelling x			

Figure 32: Genoa Installation Schedule

In a first phase of the project (before February 2012): The pilot activities were composed of two groups of dwellings. The first group consists of **16 apts** , 8 apts with internet connection available and 8 without internet connection available; 3 apts with centralized heating system and 13 apts with individual heating system, that have been equipped with the necessary to monitor temperature open/close windows and energy consumption with the following:

- Sensors for indoor temperature and relative humidity
- Sensors for open-close window control
- Electrical energy consumption meters

The second group consist of **9 apts** with centralized heating system which have been equipped with:

- Sensors for indoor temperature and relative humidity
- Sensors for open-close window control

The aim of the introduction of this second group was to collect information on indoor comfort to be able to provide useful data to the company managing the central heating at the Genoa Pilot. The aim is to help them, with information coming from the dwellings, in optimizing the distribution of the hating flows from the central point to the dwellings and to better customize the heating set points. If successful, this effort will allow for better comfort in the dwellings provided with the central heating unit and thus will reduce, where identified, unnecessary energy consumption.

Considering both groups, the Genoa pilot accounts for total of **25** equipped apartments.

In what follows some pictures depicting the sensors and energy consumptions metering installed within the dwellings are reported, as well as some pictures referring to the testing phase of the devices installation.

Figure 33: Sensor and test in Genova pilot

After the baseline period was complete, 16 Apts have been provided with an ICT device (tablet) that allows tenants to check their energy consumptions and elaborated data in real time. In Genoa, this device is the ARCHOS 70 internet tablet and using this it is possible to connect each tenant to his/her data through an application developed by ISA available at the link: cecdisplay.isa.pt.

Tablets were fielded in December 2011 using group briefings and one-on-one training sessions. These training sessions were made possible using an Internet wi-fi Key as shown in the following figure. Using this simple access point, it was possible to connect 3 devices simultaneously to support training activities.

ARCHOS 70	Internet wi-fi Key
	

This key provides at least the possibility to connect at the same time 3 different devices and, waiting for wi-fi in all the dwellings, this allows to each tenant to check his consumptions within the common area.

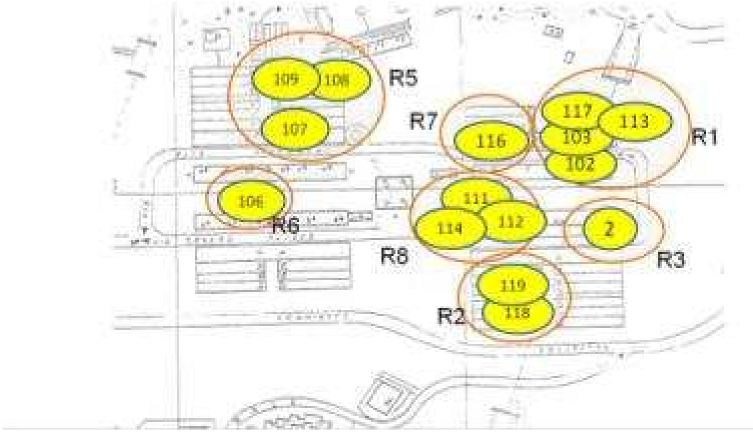
Group training	One-on-one training
	

During the implementation section people attending received:

- Tablets and related guidelines
- general training on how to use it
- customised training through real simulation
- a customised user manual (content of the training in hardcopy)

For the tenants who participated to the training course who had internet wi-fi already available, it was decided to test the tables even directly in their dwelling and this was working.

In a second phase of the project (after February 2012): Since it was not possible to build an adequate baseline of data needed for the following step of the project development (measurement of project results comparing data of the baseline period with data of the reporting period) it was decided to add a second group of dwellings acting as control group.



APTs belonging to such group were equipped only with sensors and electrical energy consumption meters (more details are reported within D 4.2.)

6.3.2.3 Planning aspects for the measurements and verification campaign

In a first phase of the project (before February 2012): Technical datasheets have been developed to collect and keep track (baseline) of the information on energy consumptions specific of the different dwellings. This allows for defining a reference baseline to which monitoring data can be compared, in line with the aim of the IMPVP methodology. Comparison and assessments before the implementation of the ICT solutions of the project can be carry out and investigated.

For each dwelling, the technical datasheet is divided into two main sections:

- General information;
- Baseline information;

The "**general info"** section contains the specific features of a dwelling gathered in order to precisely define to which dwelling we are referring to as reported below:

Contact person	
Code Apt	
Localization in the pilot	
People living in the apt	
Area of the apt	
Heating system	
Availability of internet access	

The section "**baseline information**" contains indications for the electric, water and gas suppliers and consumptions.

The total cost of **electricity service**, as recommended by the AEEG Authority, is divided into components that correspond to the cost of the services necessary to ensure the provision, the general costs of the electricity network and taxes legally owed:

- Energy Service;
- Network Services;
- Global System Services Charges.

Tenants are free to select the energy supplier and they directly receive bills form the utility suppliers. With past bills of electricity available the energy consumption's profile of last year have been defined thus allowing to understand the consumptions on the different months and time windows F1, F2 and F3 (based on the energy service only).

In compliance with article 2 of Resolution No. 237/07 AEEG Authority unit prices apply to electricity supply contracts are differentiated for:

- Peak hours (F1): from 8:00 to 19:00 during Monday to Friday (excluding national holidays),
- Off-Peak hours (F2): from 19:00 to 23:00 and from 07:00 to 08:00 during Monday to Friday, and during Saturdays,
- Night hours (F3): from 23:00 to 07:00 every days and during Sundays and national

The contracts for residential uses are mainly two:

- Unique tariff for each Watt consumed without diversification of price within the different hours
- Double tariff for Watt used in F1 or in F2+F2 time frame.

Charts like the one reported in the figure below have been developed, based on the data gathered from the bills, with the twofold objective of informing both tenants and project team on the typical electricity consumptions [kW] of the apartment.

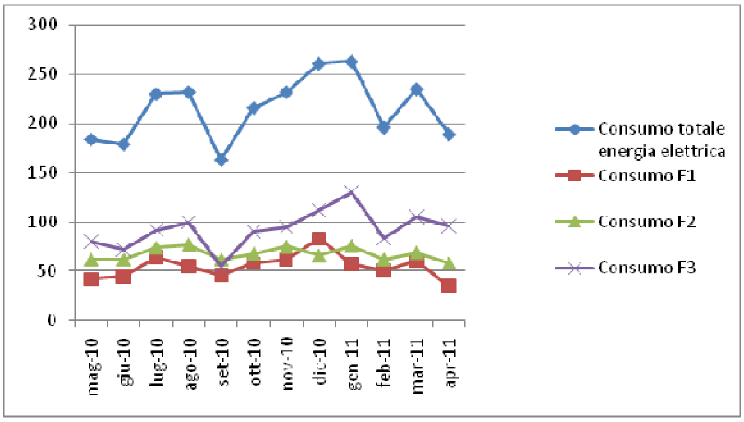


Figure 34: Monthly electricity consumption (kW) for an apt divided across the three tariff windows and their aggregated total.

The **water service** at the Genoa pilot is unique and only one meter point exists. It is located at the main supply pipe and water costs are distributed amongst dwellings based on their surface area and are invoiced to each dwelling by the "dwelling management company" (ARTE) together with the cost for general services like: maintenance, cleaning of common spaces costs for elevators. For this reason, water is not metered (at the dwelling level) at the Genoa pilot.

For **gas services** (as for the electrical) tenants are free to choose their supplier and bills are sent directly from the utility to the tenants. Gas services cover the needs for cooking, domestic hot water and for heating where dwellings have an autonomous system. For dwellings with the centralized heating system, gas consumption for heating in particular are calculated by the building manager on the basis of the overall surface area of each dwelling. Gas is not metered at the Genoa pilot.

Charts like the one reported in the figure below have been developed, based on the data gathered from the available bills, with the twofold objective of informing both tenants and project team on the typical gas consumptions [m^3] of the apartment. Data are typically related to two-three months period and is not possibly to identify the consumptions on monthly basis.

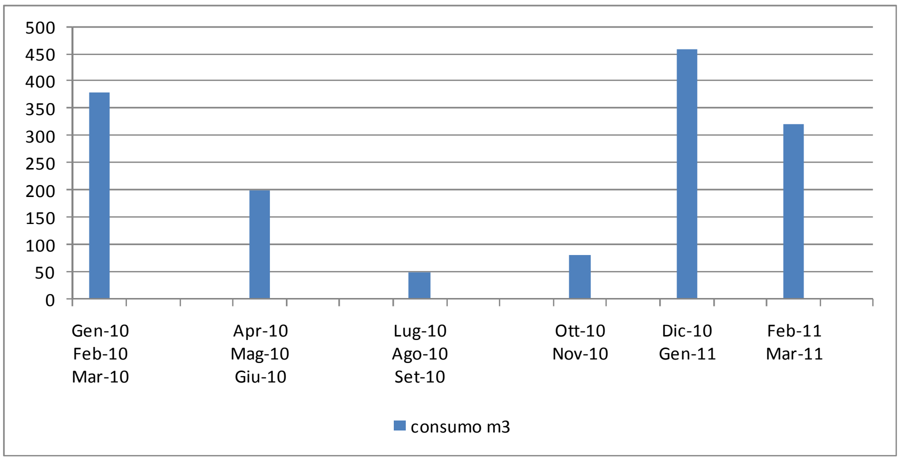


Figure 35: Gas consumption in [m3] for an apt

This kind of information is needed in order to build the baseline period and be able to compare the results with the reporting period once that the ICT solution will remain for at least one year in the dwelling to be monitored.

In a second phase of the project (after February 2012): The overall approach described above was left and replaced by the collection of data related to the control group. The analyses and comparison of data coming from the two groups are under development.

6.3.3 Key Resources

Key resources in order to realize the installations are related mainly to consumables and personnel(deeper details are collected within project Deliverable D4.2: Pilot deployment report).

Regarding the consumables and technical parts needed, they can be summarized in:

At dwelling level:

- Sensors per dwelling: 1 temperature/humidity sensor, (2 for the dwelling with two floors) 4-5window sensors for monitoring all the rooms
- Smart meters per dwelling: 1 meter for electricity, (since each mater for electricity allow the collection of info coming from three apts where possible we have optimize such part connecting two or three apt to the same meter)
- 1 tablet per dwelling (only for the apts of the monitoring group)
- 1 router and 1internet key (only for the apts of the monitoring group)
- 4-5 smart plugs (only for 8 apts).

At pilot level - equipment exploited for more than one dwelling

- Board for the deployment of the electricity smart meters,ISA repeaters for ensuring communication with all smart meters, Remote servers for hosting iEnergy and sDisplay services.
- Repeaters for common area: based on the specific situation for communication of temperature humidiy and windows sensors 2-4 repeators were fixed in the common area at different level to allow the communication of data from the dwelling to the data loggers
- Repeaters for common area: for the communication through zigbee module of the data collected by the smart plugs
- Additional antennas for the communication of data collected in the data logger to the server
- Datalogger automatic restart
- Weather station.

Regarding the human resources, the team involved in the deployment phase consisted mainly of:

- Technical installers and experts from the main technology supplier ISA: in most of the installation activities a team of two technicians from ISA was involved. Once the deployment was almost finished, the team was frequently reduced to one person, in charge for completing the last steps for getting the installation running, and checking its working status. These technicians in the field were remotely assisted also by others in ISA premises for completing configuration of equipment.
- Installation coordinator from D'APPOLONIA-one person from D'Appolonia was alwasys involved for the overall coordination and validation in the field of all the installation works. In some of the most critical phases, such as the deployment of the dashboards, or of the wireless communication network, the team was increased.
- Supporting team from building owner COMUNE di GENOVA: the supporting team from commune di Genova was normally composed of up to two social workers responsible for the relationship with the tenants with respect to access to their premises, transmission of information, and training activities. They were responsible as well for coordination with internal technical staff, getting authorizations and so on.
- Other human resources: Vodafone personnel to verify the mobile signal in the area and improve the quality of the communication.

6.3.4 Value Propositions

Considering the global aims of the project in the installation phase the addressed customers of E3SoHo are the tenants and the service manager of social housing. (In a global business model overview other stakeholders will be identified and actions needed in order to address projects results even to them will be deeply analyzed within D7.4)

	Value deliver to the customer by the project	**Problems that the project is helping to solve**	**Customer needs are satisfied by the project**
Tenant	Possibility to reduce costs for energy (bills are pay by tenants based on real consumptions)	Identification of unpredictable consumptions Identification of energy picks	Identification of comfort parameters in dwelling Identification of energy consumption profile Possibility to compare their consumption and costs for KW/h

			compared to the bill
Service manager of social housing	Possibility to check on the ienergy platform the real communication of data and the consumptions of each dwelling	Identify the possibility to have direct contract with the energy suppliers (framework supply) with negotiated tariffs	Monitoring on tenants proneness in changing behaviours

6.3.5 Channels

Channels used to reach customers are mainly:

- Building owner: this is the first channel involved -needed to identify which pilot case may be the most suitable one;
- Comitato di Quartiere: is a local institution who connect directly the authority (comune and ARTE) with tenants. It is collecting problems and needs of tenants if any;
- Tenants: final users of the solution applied. Tenants have to be in agree with the aim of the project , to allow the installation in the house and to guarantee a right use of the equipment provided.

6.3.6 Costs structure

The main costs of the project must be connected to the key resources needed.

Equipment – consumables costs:

- Equipments and ICT hardware (sensors, data loggers, cable, tablets, routers- training material). The average estimation provide a cost from 250-to 350 Euro for each apt;
  The installations in this phase were addressed to two quite small groups. The possibility to enlarge the sample involved in the implementation phase will help to reduce the cost of the single unit installed.
- Internet connection: 16 sim with limited traffic for each month have been delivered to the tenants. A part from the activation costs each sim has a flat cost of 10 Euro for each month (excluding traffic overcoming the contractual limit). Additionally other 8 sim (10 Euro for each for each month) were needed to be used for the communication of data from

routes to ISA server. Finally a sim for wifi key was purchased (20 euro each month) to perform the training sections.

Personnel costs to:

- Physically realize the installation on the pilot and configure the equipments;
- Train people on the project platform, application functionalities and information collected. (In the future the development of e-learning module could reduce the efforts for such task)

6.3.7 Lessons Learned

From the Genoa pilot activities to date, the following lessons are concluded:

- The pilot rushed for volunteers and selected dwellings based on first responders. This complicated exponentially the communication infrastructure aspects. It would have been much simpler (in retrospect) to dedicate effort to encouraging one floor or two floors of the same building to participate and focusing all aspects of the study there. The good point of the method being utilised is that is forces the true cost calculations and effort to provide services to individual tenants (islands).
- ISA is a technology provider located in Portugal. Installation activities and technical visits are therefore very deliberate decisions and events. Because timelines cannot be precisely known in advance (the duration required), arrangements for the installation team were made in real time. Because of the amount of equipment required, a van packed with materials was rented in Portugal and driven for 16 hours to arrive. The team of two installers stayed approximately 2 weeks to complete installation activities. Hotel costs and travel costs are a distinguishing characteristic in contrast to a local provider.
- Tenants were without exception helpful, interested, and collaborative.
- Cabling inside and outside the apartment buildings (not within dwellings) was a significant effort and time consuming.
- Also because pilot activities were planned in a quick manner, it was not possible to work with utility companies to discuss changing meters, extensive permission processes, etc. This limited what was possible at the pilot to electrical sub-metering (e.g. water and gas were not possible).
- For technical visits, coordination required the involvement of many stakeholders. Each aspect of the building is contracted to different agencies (e.g. central heat is contracted to a company which is different to the building manager who is different than the supplier of the natural gas all requiring different access points to obtain a complete analysis of gas/heating).

- Being present at the pilot for coordinating in situ activities, for solving the issues which may arise within the sensors and the communication infrastructure is something that allows in getting prompt and fast answers and solutions that helps in better deploying the activities and finally to provide info to the tenants not involved and aware of project objectives.
- Awareness and training activities as well as training materials are vital to keep the tenants informed on what is going on (installation activities and installation phases) and to provide them with the needed level of confidence with the information available from the ICT system implemented in their pilot and from the sensors and devices installed in their dwellings.
- Training activities are particularly relevant when making the tenants the main actor of the situation by allowing them to directly check their own energy information/data by means of an interactive dashboard (tablet). Training them in an exhaustive way will allow for moving across the deployment of the pilot monitoring activities in a very efficient manner. This will imply not to face with unsolved issues and to talk to people that have got enough knowledge of what is happening. This means that when new elements will be introduced to them and when new actions/efforts/behaviour will be suggested they will promptly understand what we are asking them and they will easily check what this implies in terms of energy consumptions and costs savings.
- Control Group: the apts of the control group have to be chosen try to exploit part of the common equipment already installed and must be representative in terms of structural features and occupants profiles (number, age, occupation etc).

7. Methodology: From EU Project to Industrial Business Services

This chapter is included to document and clarify how project activities shape the E3SoHo methodology and how this methodology becomes replicable at a wider scale.

7.1 Building the Methodology

Methodology development runs in parallel with the entire project and is documented in four project deliverables:

D6.1: Methodology for Design

D6.2: Implementation

D6.3: Monitoring

D6.4: Global Methodology

Building this methodology is a push-pull approach during which the methodology provides upper level (or top-down driven) input to guide project activities and then receives bottom-up feedback from the conduct of those project activities to complete and refine the final methodology. Interdependencies between the methodology and project activities are generally outlined in the following figure.

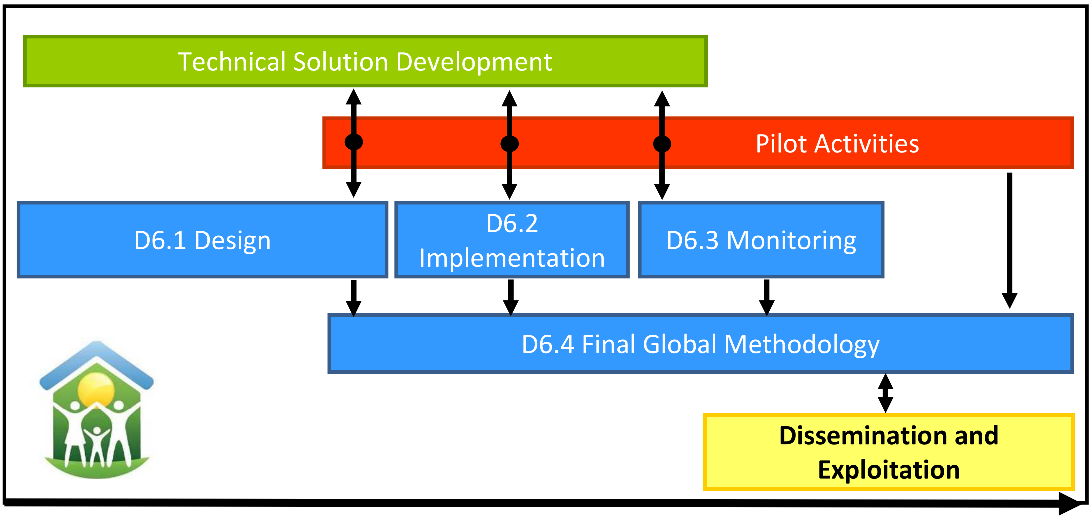


Figure 36: Interdependencies between methodology and other project activities

D6.4 (Global Methodology) has a special role. It receives the final output from the methodology sub-deliverables (design, implementation, monitoring) and all lessons learned from the pilot activities to close the feedback loop and document the final E3SoHo methodology. This deliverable is also important in that it is part of a knowledge development loop with dissemination and exploitation activities by which business models (for use by persons external to the consortium) and exploitation plans (for use by consortium members) are considered.

Fundamental to the methodology development approach is that the best available background from consortium partners is made available, integrated, and then refined into foreground through the conduct of project research and pilot activities.

7.2 Branding and Image Building through Collaboration, Dissemination, and Benchmarking

This sub-section is included in this implementation deliverable to highlight the planning and execution activities related to building the image/brand for the developing services with the future intent of exploitation and exporting the project methodology developed by E3SoHo to other cases around the EU.

One of the key pillars of any research project is to drive activities to the development of a prototype to be proposed to the market as a new solution or as the improvement of something already existing. In the E3SoHo project, the research will deliver a global methodology for the application of ICT solutions within Social Housing allowing the reduction of energy consumption.

In particular the concepts developed within this report provide indications and guidelines for future replications of the E3SoHo or like services across implementation activities. The checklists developed for planning and execution along with the lessons learned during the E3SoHo pilot activities should help the readers and potentially interested organizations willing to apply our methodology in identifying common aspects and differences with their specific case studies and to help them adapting our results to their specific context.

In order to export the E3SoHo methodology, it is necessary to share directly with relevant stakeholders, in order to validate, improve and transfer the results. One efficient and effective way to do this has been to network through other past and present EU projects that share similarities with E3SoHo. This network is shown in the corresponding figure.

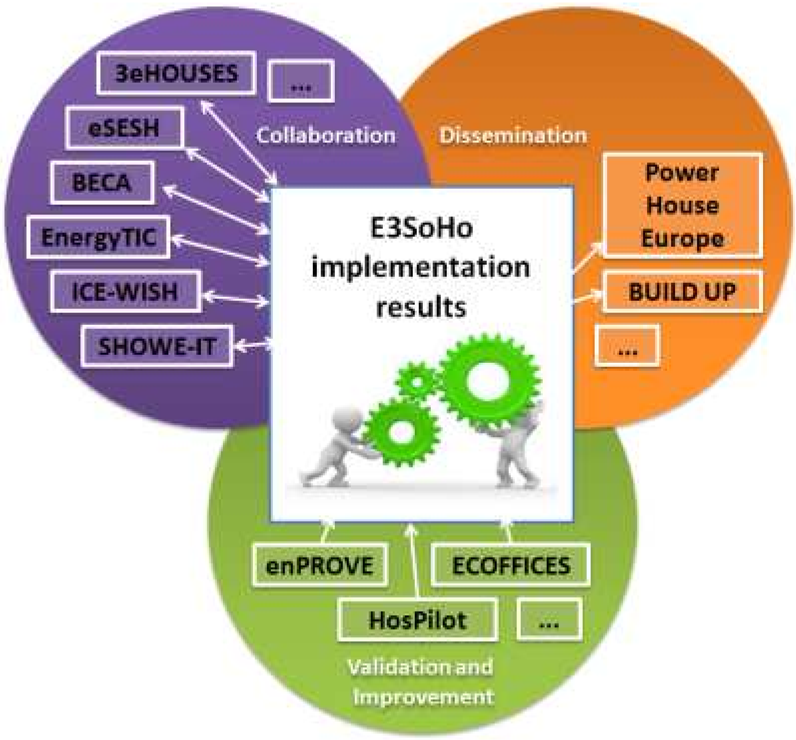


Figure 37: General approach for sharing E3SoHo methodology outcomes

The following sub-sections identify the stakeholders that make up this network and the best way to approach them to exchange best practices and lessons learnt.

7.2.1 Collaboration with other projects focusing on ICT & Energy Efficiency & Social Housing

A number of projects are working on the exact same topics as E3SoHo, i.e. ICT applied to social housings for improving their energy efficiency. This includes the projects that have been funded on the same EC call (eSESH & 3eHouses), and that have the same time frame for the development of their pilots. With these 2 projects, **collaborative workshops** aiming at harmonizing the project methodologies, especially for monitoring, have been organized, thanks to an initiative led by the European Commission.

New projects have been selected on a new similar call (BECA, ICE-WISH, SHOWE-IT, EnergyTIC) and might be able to exploit some of the previous projects results, especially those related to methodology aspects. Workshops with those projects will be therefore also necessary: this will be partly achieved through the series of **national workshops** to be organized in each pilot's country.

As an example, the first of these events is the French National workshop that will be organized in Angers, on February 2nd-3rd 2012. An image from this workshop is provided below.

This event is co-organized by E3SoHo, eSESH and BECA, and one of the objectives is especially a discussion on lessons learnt by eSESH & E3SoHo, for a possible transfer to the newly started BECA project. Similar workshops will be organized in other countries in 2012-2013 (see also WP7 deliverables for further details).

Figure 38: Website preview of the First National French Workshop on ICT for EE in SH, Angers, 2-3 February 2012, www.workshop-tic-logementsocial.fr

Also at the local level, national projects and initiatives appear as very relevant, and need to be associated to those events. For instance, the "Habitat Social Connecté" French project (http://www.habitat-social-connecte.fr/), is funded by Region PACA and European Regional Development Funds (ERDF), and aims at developing a digital platform of services for social housing. This project has been invited to participate to the first French National workshop.

A preliminary list of project projects focusing on ICT & Energy Efficiency and Social Housing has been established, and is provided in the Table 1 below, as well as through a publicly available Google Map (corresponding figure).

Table 2: ICT for Energy Efficiency in SH projects: Duration & pilot locations

Project	Year	Pilot locations
eSESH	2010-2013	• Linz, Austria • Westerlo, Belgium • Angers, France • Moulins, France • Frankfurt, Germany • Karlsruhe, Germany • Solingen, Germany • Brescia, Italy • Piacenza, Italy • Pesaro, Italy • Catalonia, Spain • Extremadura, Spain
E3SoHo	2010-2013	• Genoa, Italy • Warsaw, Poland • Zaragoza, Spain
3eHOUSES	2010-2013	• Sofia, Bulgaria • Leipzig, Germany • Sant Cugat, Spain • Bristol, UK
BECA	2011-2014	• Ruse, Bulgaria • Havirov, Czech Republic • Darmstadt, Germany • Torino, Italy • Belgrade, Serbia • Manresa, Spain • Örebro, Sweden
ICE-WISH	2011-2014	• Genk, Belgium • Sofia, Bulgaria • Aahrus, Denmark • Saint Quentin Fallavier, France • Bamberg, Germany • Larissa, Greece • Firenze, Italy • Warsaw, Poland • Bilbao, Spain • Bournemouth, UK
SHOWE-IT	2011-2014	• Saint-Etienne, France • Botkykra, Sweden • Rochdale, UK
EnergyTIC	2011-2014	• Arras, France • Lille, France • Malaga, Spain

Habitat Social Connecté	2011-2014	• La Valette du var, France

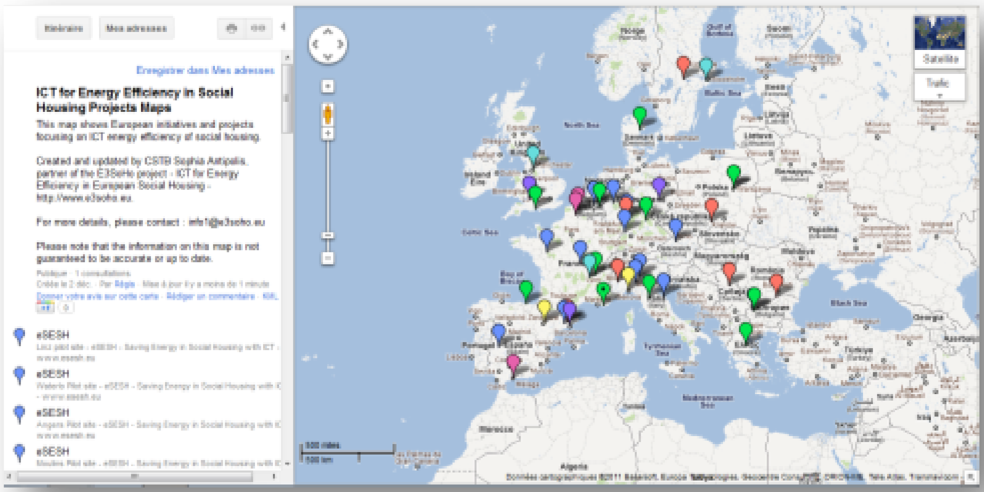


Figure 39: ICT for Energy Efficiency in SH Projects Maps – Google map created by the E3SoHo project, accessible at http://maps.google.com/maps/ms?msid=216740587045057907119.0004b31cd495 10e00d503&msa=0

It is noteworthy that the European Commission has also launched a call for tenders in June 2011 aiming at defining a Methodology for energy-efficiency measurements applicable to ICT in buildings (**SMART 2011/0072**). The call particularly includes the design of **a software tool** that should be accessible via the web and designed in a way that it can accommodate energy savings data from residential buildings & non-residential energy savings projects. The call further mentions that the methodology developed by the three social housing projects eSESH – E3SoHo – 3eHOUSES should serve as a basis.

This upcoming software is an important tool for collaboration around the methodologies aspects of the different projects. E3SoHo is prepared for the collaboration with the contractors selected for the implementation of this tender.

7.2.2 Relevant EEB web portals for dissemination of the E3SoHo methodology outcomes

Although not specifically centered on the use of ICTs, there are online resources centers focused on Energy Efficient Buildings that appear as very relevant places for sharing E3SoHo results. 2 web portals are referenced hereafter:

Power House Europe - The big green housing exchange – is an initiative coordinated by CECODHAS Housing Europe (E3SoHo partner), the network of national and regional social housing federations including 4.500 public, voluntary housing organizations and 28.000 housing cooperatives. Through its website, Power House Europe provides a map of case studies around Europe, as well as a search engine for browsing those case studies according to their focus (Financing and management, Architecture, type of building services, Knowledge and support, Renewable energies, Monitoring and certification). Two figures from the powerhouse Europe portal are provided. Of interest, the E3SoHo pilot sites are already referenced.

A second relevant source for information is the **BUILD UP portal** which gathers an important collection of case studies related to Energy solutions for better buildings, some of them being especially targeted to social housing (figure also provided). Among those articles, some are related to social housing organization looking for innovative financing schemes for funding their sustainable development. These organizations appear as very relevant target for disseminating E3SoHo methodology outcomes.

The publication of an article on one of those portals, describing in details the technology implementation within the E3SoHo pilots, is a typical action that can be undertaken to share our methodology and encourage external actors to capture it for their own projects.

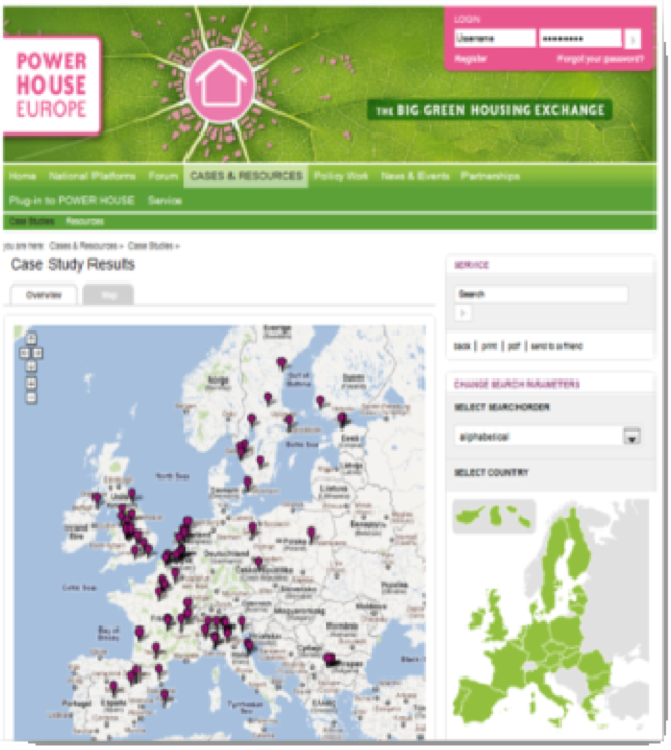


Figure 40: Map of Energy Efficient Social Housing case studies by Power House Europe, http://www.powerhouseeurope.eu/cases_resources

Figure 41: Search engine for browsing Power House Europe Case studies, http://www.powerhouseeurope.eu/cases_resources/

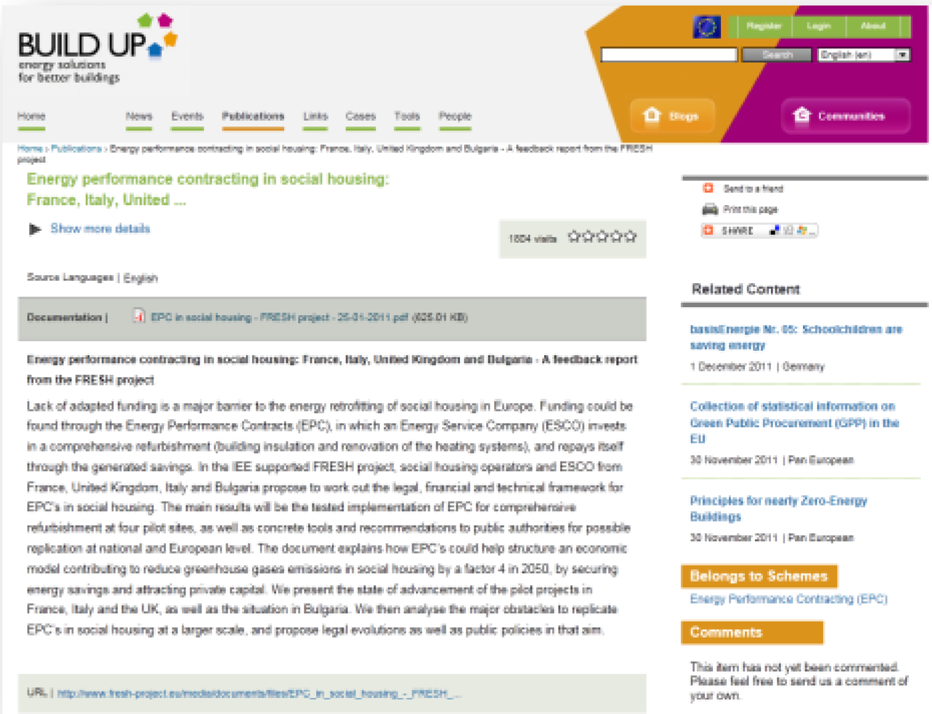


Figure 42: Example of social housing case study related to financing schemes found on the BUILD-UP web portal - http://www.buildup.eu/publications/14410

7.2.3 Validation and improvement of the E3SoHo Methodology through exchange of lessons learned with ICT for EEB projects focusing on different types of buildings

It is always interesting to look at lessons learnt from other ICT4EEB projects, even if they are not focused on the specific target of social housing. The building environment, its constraints, and the associated business model for future exploitation are obviously different than for the social housing case, but most often the technology and its implementation are quite close. 3 examples are briefly presented hereafter.

The **enProve** project (FP7-248061) has developed the concept of a tablet computer (e.g. iPad) application for facilitating the installation of the sensors and equipments in a building. The basic idea is that through the application, the installation team would be able to:

- rapidly visualize the list of hardware components needed (e.g. sensors, sub meters) when entering a building room to be equipped ;
- Read for each hardware component its exact reference number and its intended location within the room (e.g. window contact sensor n°xxx has to be installed on the left window).
- Check through the application the good quality (raw) signal reception of each hardware component once it is installed within the room (e.g. watching thanks to a basic colored indicator that the signal is correctly received when opening/closing the window equipped with contact sensor n°xxx)

This concept is especially relevant when the envisaged technology deployment is considered on a large-scale. It could be therefore relevant to integrate this concept within the E3SoHo methodology when the envisaged installation is covering more than e.g. 50 social housing apartments, and/or 100 sensors. The corresponding figure provides a theoretical illustration of what the application could look like.

Figure 43: Possible user interface for a tablet-based application supporting the installation and deployment of ICT sensors and meters within a building

The **ECOFFICES** – Energy Challenge within OFFICES (PACA Labs French National project funded by Region PACA and ERDF) project has experimented an eco-behavior challenge enabled by ICTs between different team of employees belonging to the same company. The project has involved 49 challengers and more than 400 sensors (most of them being wireless) have been deployed in the demonstration office building. Lessons learnt during the installation phase are in the end quite similar to some lessons learnt from the E3SoHo project. A short selection of encountered difficulties/recommendations from the ECOFFICES project:

- Plan the risks of potential delays for hardware supply, shipment and delivery;
- When using wireless sensors, make a preliminary test of the signal range and quality within the building to be equipped, in order to check potential issues of signal transmission (e.g. due to wall material, etc.). In some cases, results might be quite different than the sensor technical specifications provided by the manufacturer;
- Study accurately the sensors technical specifications. For instance for a presence / motion detection sensor, clearly identify which spectrum / angle of detection is actually covered in order to define the optimal sensor location within the room;
- Anticipate potential troubles of battery lifetime, especially with new products / prototypes.
- Anticipate potential data deterioration due to the interactions between RF signals and metallic objects. This type of conflict usually leads to exponential values or outliers.

Additional lessons learnt from the ECOFFICES project are available through the public reports from the project (available on request through www.ecoffices.com)

The **HosPilot** project (CIP-238933) is focusing on intelligent energy control in hospitals. In this project, an interesting approach consists in the design of a decision support tool for building owners and/or facility managers. The idea of this decision support service is to support in the selection of the best ICTs (HVAC, Lighting, and Controls) for a given building, taking into account the building specific characteristics, its current energy equipments, and the available funding for refurbishing. The tool establishes a prioritized list of Energy Conservation Opportunities, according to the expected savings and return on investment.

Within E3SoHo, the selection of ICT for each social housing pilot has been established based on the expertise of the consortium partners. Though, it could be envisaged to adapt the HosPilot decision support tool to the social housing context. (Additional details on the HosPilot tool are available from the HosPilot website www.hospilot.eu)

A process of technology watch is established along the E3SoHo project duration, so as to screen related projects progress and identify potential improvement / extension for the E3SoHo methodology.

To summarize the approach being used to share the E3SoHo methodology are:

- **Collaboration** with R&D projects also targeting the field of ICT for EE in SH, so as to harmonize our respective strategies, approaches and methodologies
- **Dissemination** of the methodology concept - and its application to the pilots – via publications of articles and case studies on relevant web portals with wide audience
- **Benchmarking** and **improving** the methodology through a technology watch of other R&D projects dealing with ICT for EEB (but not necessarily targeting social housing).

Through these activities, the consortium is being exposed to excellent ideas and like minded industrial partners. This widens the project network and establishes the conditions for broad scale replication.

7.3 Business Services

The methodology deliverables (design, implementation, monitoring) are structured to address future business services. As the project now moves into its final phase (pilot activities), exploitation strategies will be specified and refined and reflected as a part of final global methodology (D6.4). These refinements will include:

- Identification of Appropriate business models (Task 7.1)
- Through WP5 (Monitoring & Validation) an understanding of the costs, maintenance requirements, and savings value of the deployed services at the pilot locations
- Consideration of the socio-economic aspects of the deployed solutions (Task 7.3)
- Development of the promotion and exploitation plan (Task 7.4)

8. CONCLUSIONS

The success of ICT energy efficiency solutions will be in part directly related to the activities surrounding their implementation. To this end, this report has provided methodology, best practices, insights, and lessons learned related to:

- Managing the period between design and implementation
- Planning installation activities
- Executing installation activities
- Supporting end users through awareness and training

These activities are critical as glitches in these areas (unplanned or unforeseen events, technical problems, etc.) likely result in delays, frustration, extra costs, and/or wasted resources. In the event of poor awareness sand training, the end result is likely a system that is not put to its best use or one that is forgotten or dormant soon after its installation because it is never well accepted by the end user.

In contrast, successful implementation activities likely excite the end user, encourage self-learning and result in referrals for future business activities. It should be noted that implementation is not the first impression but potentially the most important impression because it is when the system becomes personal to the end user. It is the first time they interact with the system and make their decision whether or not it brings value and change to their life and behaviours.

Chapter 7 of this report includes the first methodology linkage to dissemination and exploitation activities with the end target of developing industrial business services beyond project completion. In time, this report will be followed in time by D6.3 "Methodology for Monitoring" in which the methodology for data analysis and lessons learned from the pilots will be detailed. Later, D6.4 "Global Methodology" will incorporate lessons learned from across the technical development and pilot activities to include a special treatment of business models and exploitation activities.