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1 Abstract

The overall objective of E3SoHo project is to implement and demonstrate in 3 Social Housing pilots an integrated, interoperable and replicable ICT-based solution which aims to bring about a reduction of energy consumption in European social housing, by changing the behaviors of tenants towards energy efficiency without compromising their comfort.

E3SoHo proposes a holistic service that provides advice on how to reduce energy consumption in social housing, through the design of an ICT solution, the deployment of the ICT solution in the building, the training of the end users (tenants and building owners), and the monitoring of the ICT solution to evaluate the energy savings achieved.

The ICT solution provides tenants with feedback on their consumptions (electricity, heating, and domestic hot water), and offers them personalized advice and alerts.

Building owners are also provided with management tools for remote visualization of aggregated consumptions (and if applicable, energy production) of the building, which can be used as support for improving energy management strategies and for assessing the accomplishment of refurbishments.

The E3SoHo service is built up of the following sub-services that can be provided separately:

- Perform an audit in the building to identify the energy saving potential.
- Provide the owner with an ICT based blue-print to reduce the energy consumption.
- Implement the system according to the blue-print
- Tuning of energy consumption by monitoring before and after the implementation of the ICT solution
- Maintenance of the installed system.

2 Introduction

The ICT *Policy Support Programme* (ICT PSP)[1] is one of the three specific programmes of The *Competitiveness and Innovation framework Programme* (CIP) and runs for the years 2007-2013. The ICT PSP aims at stimulating smart sustainable and inclusive growth by accelerating the wider uptake and best use of innovative digital technologies and content by citizens, governments and businesses.

It provides EU funding to support the realisation of the Digital agenda for Europe.

The programme addresses obstacles hindering further and better use of ICT based products and services and barriers for the development of high growth businesses, notably SMEs, in this

[1] http://ec.europa.eu/digital-agenda/en/ict-policy-support-programme

field. In addition to illustrating and validating the high value of digital technologies for the economy and society, it will foster the development of EU-wide markets for innovations enabling every company in Europe to benefit from the largest internal market in the world.

Particular emphasis is put on areas of public interest given their weight in the European economy and the unique solutions that ICT can bring to the societal challenges that lie ahead such as health and ageing, inclusion, energy efficiency, sustainable mobility, culture preservation and learning as well as efficient public administrations. The main challenges include the relatively slow uptake of ICT innovations in the public sector and the high fragmentation of relevant markets due notably to a lack of interoperability between ICT solutions deployed across the Member States and Associated Countries.

The E3SoHo project is one of the CIP projects dedicated to the energy efficiency on Social Housing, with an emphasis on Energy Awareness tools and services for tenants and building owners/managers. In the next section we will briefly revisit the project objectives and their rationale, the pilots' results followed by the socio-economic impact, the conclusions and lessons learnt, the target audience and the performed dissemination of results.

3 The objectives

The overall objective of E3SoHo project is to implement and demonstrate in 3 Social Housing pilots an integrated, interoperable and replicable ICT-based solution which aims to bring about a reduction of energy consumption in European social housing, by changing the behaviors of tenants towards energy efficiency without compromising their comfort.

The ICT solution provides tenants with feedback on their consumptions, and offers personalized advice and alerts.

Building owners are also provided with management tools for remote visualization of aggregated consumptions (and if applicable, energy production) of the building, and which can be used as support for improving energy management strategies and for assessing the accomplishment of refurbishments.

E3SoHo proposes a holistic service that provides advice on how to reduce energy consumption in social housing, through the design of an ICT solution, the deployment of the ICT solution in the building, the training of the end users (tenants and building owners), and the monitoring of the ICT solution to evaluate the reduction of energy consumption.

The E3SoHo service is built up of the following sub-services that can be provided separately:

- Perform an audit in the building to identify the energy saving potential.
- Provide the owner with an ICT based blue-print to reduce the energy consumption.
- Implement the system according to the blue-print
- Tuning of energy consumption by monitoring
- Maintenance of the installed system.

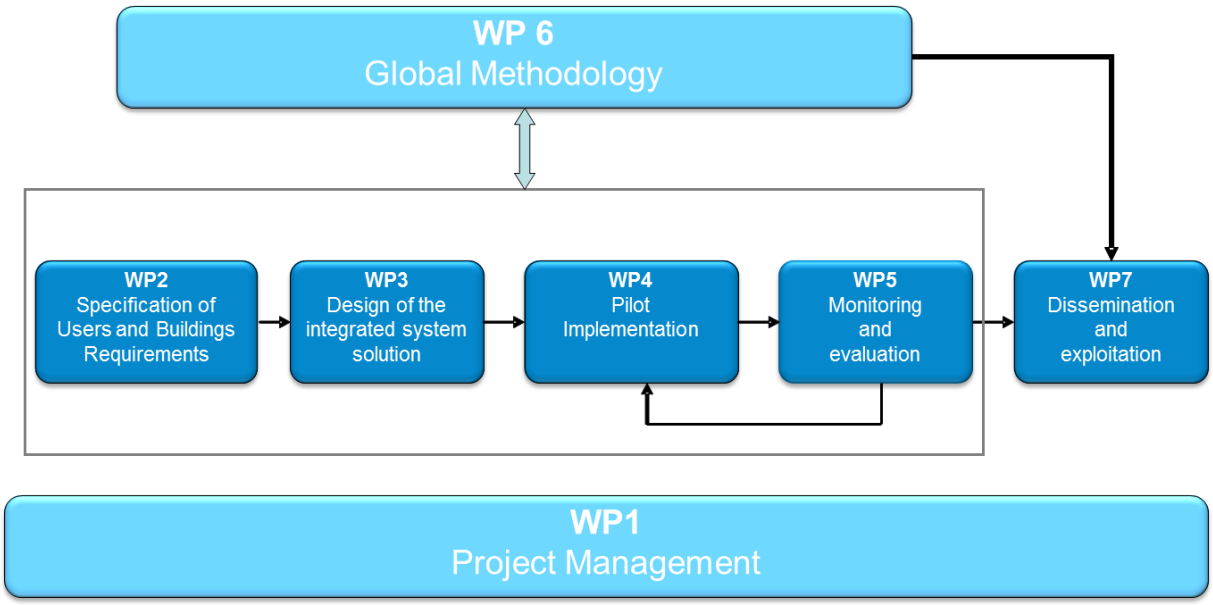
This service and subservices will be disseminated to the open market through different routes for exploitation and business models. A global methodology including design, implementation and monitoring of the ICT solution and guidelines for replication has been produced.

Partial objectives will be:

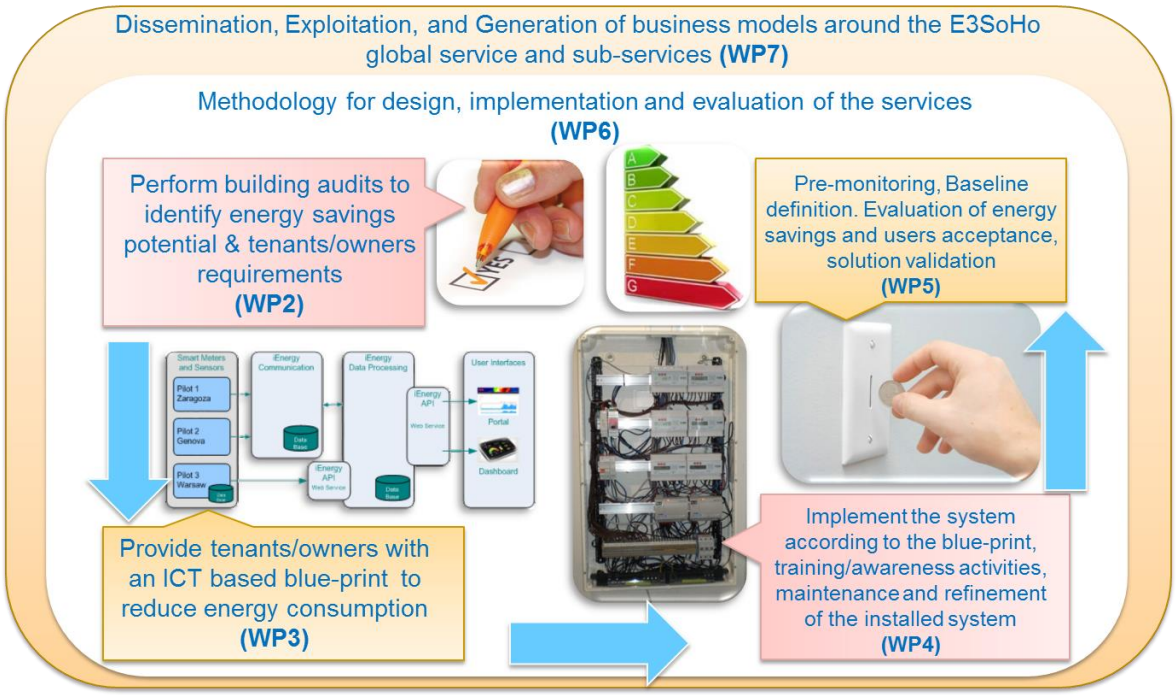
- To identify users and building requirements
- To design the integrated ICT solution
- To implement the solution in the pilots
- To monitor and evaluate the energy savings
- To develop a global methodology for design , implementation and monitoring the ICT solution
- To disseminate the project results
- To outline a marketing and exploitation plan for the project results

4 The work carried out to achieve the project's objectives

The work plan has been divided in 7 work packages:



The figure below gives more insight into the general objectives of each work package:



WP1. Project management

The objective of WP1 has been to ensure a sound coordination and management of the project covering technical, administrative, legal and financial issues, and the relation with the European Commission. For that purpose the necessary governance structure has been created and operated for an effective project direction and management to achieve the expected project results, establishing the communication flow and methods and the quality plan.

WP2. Specification of users and buildings requirements

A set of users' (tenants and building owners) requirements (in the pilots in particular) have been collected through questionnaires and visits and then, specified and evaluated. In parallel, social buildings requirements (in the pilots in particular) have been collected through visits and audits and then specified and evaluated in terms of ICT infrastructure necessary for potential energy savings. Later on, the best technical and cost-effective ICT possible solutions have been identified.

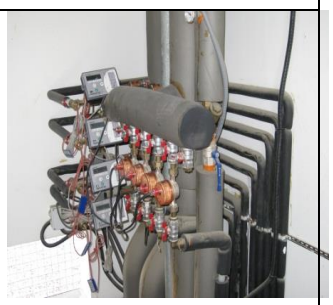
ZARAGOZA PILOT

Owner: Zaragoza Vivienda. **Year of construction:** 2002. **No of floors**: Ground + 8

No of dwellings: 43 (16 active). **No of users:** > 120 (46 active)

Heating: 2 Central gas boilers. **DHW:** Solar thermal + gas





WARSAW PILOT

Owner: City of Warsaw, **Year of construction:** 2007, **No of floors:** Ground + 4

No of dwellings: 48 (16 active in the project), **No of users:** 111 (34 active)

Heating: Central gas boiler, **DHW:** Central gas boiler



GENOA PILOT

Owner: Comune di Genova / Private, **Year of construction**: 1980-1990

No of dwellings: 350 belonging to Comune (30 active in the project: 15 monitoring + 15 control), **No of users:** > 500 (> 60 active in the project)

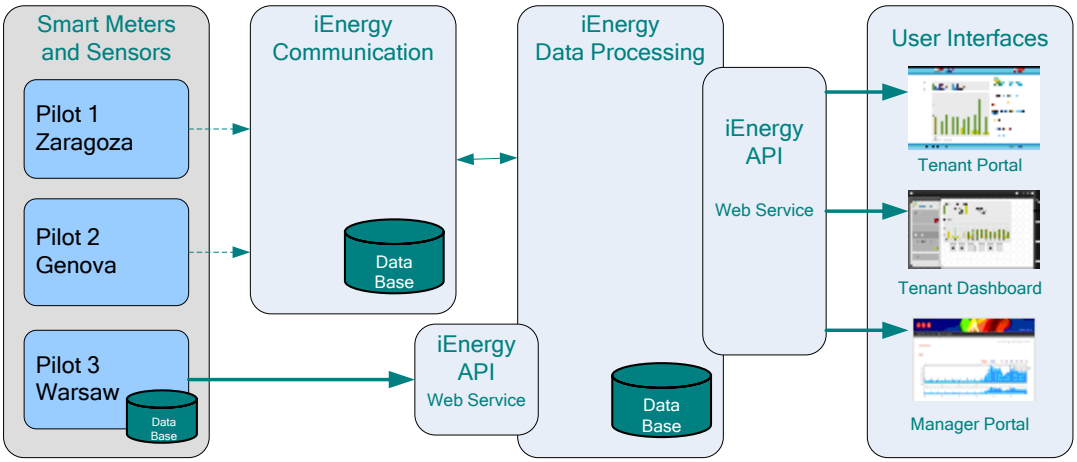
Heating: Central thermal power plant, **DHW:** Gas



WP3 Design of the integrated system solution

Firstly, the pre-monitoring and monitoring infrastructure (meters, sensors and communication devices) have been selected for each of the 3 pilots. In Zaragoza and Genoa products from one of the partners (ISA) have been selected. In Warsaw the devices selected were from other providers external to the consortium. Secondly, an integrated ICT solution prototype was produced based on ISA's iEnergy platform, and finally the complete ICT solution integrating metering infrastructure, the iEnergy platform and the graphical user interfaces for tenants and building managers/owners was delivered.

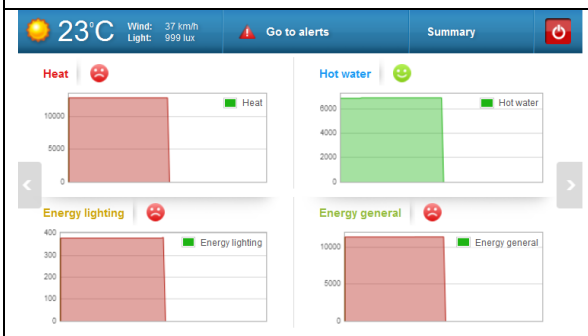
Architecture of the integrated ICT solution



WP4. Pilot Implementation

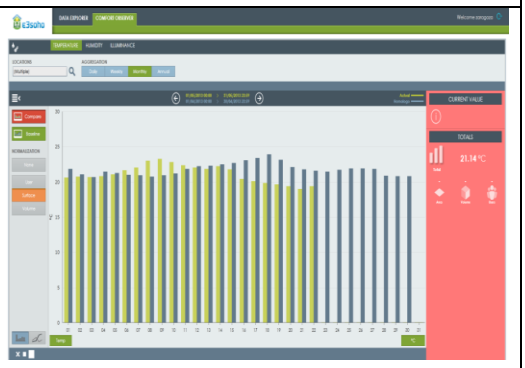
In this work package the monitoring infrastructure defined in the previous WP3 was deployed, and the energy consumption measured during a year before the installation of the full ICT integrated solution (including graphical user interfaces) was operative, in order to establish the baseline consumption for further comparison and calculation of the variations in energy consumption. Afterwards, the full ICT solution was installed (deployed) users (tenants, building owners) were trained, and during a year it has been operative and the energy consumption has been monitored. Finally the ICT solution has been refined in accordance with the feedback collected from questionnaires providing more user-friendly interfaces to tenants and owners.

Tools for tenants



Screenshot of VAS interface for tenants used in Warsaw (English version)	**Screenshot of sDisplay interface for tenants used in Zaragoza**
Energy consumption information • Electricity (global and partial) • Hot/cold water • Heating	Comfort data • Temperature/Humidity Historical data
Monthly targets, Advices, Smart Alerts	User interfaces: Android and web applications

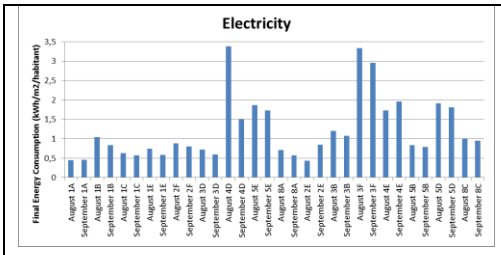
Tools for building owners/managers



Screenshot of iEnergy web interface	**Screenshot of refined user interface**
Energy consumption information • Monitored dwellings • Total building consumptions Energy production • Solar thermal Devices management	Historical data Comfort data • Common areas • Meteorological data

WP5. Monitoring and evaluation

Within this WP the energy consumption and other parameters have been monitored after the implementation of the ICT solution, and the performance in terms of energy savings has been calculated, while the change of behaviors and user acceptance have been assessed through questionnaires and interviews with the different stakeholders. Finally a validation, meaning a comprehensive assessment of the ICT solution developed and refined during the duration of the project, of the pilot implementation and monitoring, from the technical, social, energy saving, users' acceptance and economic point of view has been carried out.

		
Analysis of energy consumptions	Tablet installed in one dwelling	ISA iMeters for electricity consumption

WP6. Global methodology

Based on existing methodologies and results from past projects' results on social housing and collaboration with other CIP-ICT-PSP projects a "common methodology" has been developed. On top of this the E3Soho project has developed a methodology for ICT solution design, implementation, and monitoring that have been integrated in a global methodology including guidelines for replication.

WP7. Dissemination and Exploitation

A website has been built up since few months after the initiation of the project and has been updated and maintained along the project duration and beyond. Several dissemination plans have been released in which the activities planned for the next period and carried out in the reported period have been detailed. A Socio-economic and market positioning study has been produced, Busines models have been analyzed, and finally a Marketing and exploitation plan has been outlined for future actions towards replication and exploitation.

5 The main results and achieved impact

After the conclusion of the E3SoHo project, the following results and their impact can be highlighted:

- E3SoHo project has delivered a refined, integrated, interoperable, replicable and cost-efficient ICT solution for energy efficiency in social housing, targeting:
    - Awareness and behavioural change of tenants towards energy use. Tenants can use the E3SoHo ICT solution through intuitive user interfaces which can be accessed either as a native Android application, through any tablet with this operating system, or as a web application, through any other device with Internet connectivity and standard browser.
    - Provision of adequate information to building owners/managers for remote visualization of aggregated energy consumption and production of the buildings.
- The ICT solution has been successfully deployed in 62 dwellings (including 15 dwellings of a control group in Genoa) in three pilot sites in three different countries. The interoperability of the solution has been tested at two different levels: integration with a single data processing and storage platform (iEnergy) of metering and sensing equipment from different vendors, and integration of the aforementioned different user interfaces for tenants and building owners/managers, enabling its use in the three pilot sites.
- A comprehensive training program for social housing tenants has been designed, aimed at increasing their awareness on efficient and rational use of energy at domestic level, and getting them familiar with the use of the E3SoHo ICT solution. This training program has been adapted and implemented in the different European regions where the project pilot sites are located, following the different installation phases of the ICT solution, and complemented with follow-up individual and collective sessions for maintaining users' engagement and providing technical assistance.
- The use of the ICT solution during one full year have yielded tangible results of energy savings achieved through ICT awareness-only tools: two thirds of dwellings in Zaragoza and Warsaw pilot sites have reduced at least one type of energy consumption. At pilot level, global savings of up to 7% have been achieved (in the Zaragoza pilot site), while the savings per energy type reach 10% in the case of heating, and almost 8% in the case of electricity.

- The engagement of social housing tenants of the pilot sites with the E3SoHo project and the use of the ICT solution can be considered as satisfactory, even if there is still room for further improvement, as nearly one half of the tenants reported having used the ICT solution, and one third reported having changed their behaviour towards energy efficiency after participating in the project.

- E3SoHo project has delivered, together with its sister ICT PSP projects, a Common Methodology for design, implementation and monitoring of ICT solutions for energy efficiency in social housing, which have been complemented with the E3SoHo specific Global Methodology, including guidelines for replication, which represents a body of knowledge which can be re-used for future similar projects.

- A comprehensive dissemination plan has been defined and implemented throughout all the phases of E3SoHo project, which main highlights have been the preparation and periodic update of the public website (www.e3soho.eu) and electronic newsletters, the participation of project partners in 69 conferences, and the organization, in collaboration with sister ICT PSP projects, of 4 National workshops and 1 European workshop, with a total audience of 250 attendees.

- E3SoHo partners have looked into the most appropriate business models which can be used, complemented with feasibility studies, in order to ensure a wider adoption of the ICT solution beyond the end of the project. These studies will support the future replication of the E3SoHo ICT solution in additional social housing buildings, either in the same cities of the project pilot sites, for which specific replication plans have been designed, or in other cities of any country in Europe. Specific individual and joint exploitation plans have been defined for the whole consortium and for each project partner, in order to ensure the commercial exploitation of the project results, as well as its further dissemination to the stakeholders involved in the full value chain of ICT products for energy efficiency in the residential sector.

- The conclusions and lessons learnt in the project can also be considered as one of its main results, as they form a body of knowledge from which E3SoHo partners will benefit for future exploitation of the other results. Other stakeholders outside of the consortium will benefit from this knowledge too, as most of it is available in the project public deliverables which can be downloaded from the E3SoHo project website. Thus, conclusions and lessons learnt will support the future replication of project results in other buildings, even if other ICT solutions different to the one implemented by E3SoHo are chosen.

From the results mentioned above, it can be highlighted that the main **technical** result of the E3SoHo project is the development (in the sense of adaptation and enhancement) of an integrated ICT system composed of:

- A communication and data processing platform (**iEnergy**)
- A user interface for the tenants, allowing them to consult the history of consumptions, to view the consumptions in real-time, to check comfort conditions and to be alerted of threshold conditions and consumptions (**sDisplay**).
- A user interface for building managers, allowing them to consult and compare aggregate consumptions and other parameters associated with common equipment and areas, providing also a flexible alarm management engine (**BMUI** – Building Managers User Interface).

Interoperability of the E3SoHo global solution has allowed the integration of two different user interfaces for the tenants: sDisplay and VAS – Visualization and Alert System, and others may follow.

At the field level, the E3SoHo solution has the flexibility to communicate with a large variety of sensors and meters from different vendors, and to be integrated with existing Building Management Systems (BMS) and Building Energy Management Systems (BEMS).

Additionally, due to the development of VAS, an additional solution only for tenants has been developed composed by:

- Pilot local database specification for data collection and storage
- **VAS** – Visualization and Alert System: ICT Graphical User Interface (web application) providing energy consumption visualization, awareness and alerts for the tenants.

As explained above, the E3SoHo ICT solution has two variants, each of which composed of different blocks, which in some cases could also be exploited independently as stand-alone products. Besides, the technical products could be exploited together with value-added services, such as the energy audits, training activities, maintenance, etc., or they could be provided separately. This wide range of options has led the consortium to define the table below, which lists the main identified exploitable products and services of the project. For each product/service, the following issues are considered:

- Description of the product/service
- Degree of maturity/Time to market
- Application sector/customers

- Partners developing the product-service/other partners for exploitation
- Associated business models
- Routes for exploitation
- IPR owners/ Right of partners for use and exploitation-replication under favourable conditions

Table 1. Exploitable products and services

Product/service description	Maturity/Time to market	Application sectors/customers	Partners developers / Other partners for exploitation	Business models associated	Routes for exploitation	IPR- Owner(s)/ Right of use in favourable conditions
1. Energy Auditing (building and user requirements) and for establishing energy consumption baseline	Mature. Available capacity	Public and Private Social housing building owners. Tenants of social housing. Private building owners and Facility managers	CSTB, Nobatek, Dap, Acciona, Mostostal	Ownership model: Consulting services:	Direct service through sales network	N.A.
2.E3Soho ICT solution design, installation, commissioning and maintenance integrating metering infrastructure (ISA/ others),communication storage and processing platform iEnergy and user interfaces for tenants sDisplay or VAS and owners BMUI	Stable and tested prototype/6months. Simplified solutions for affordability	Public and Private Social housing building owners. Private building owners. ICT solutions &BEMs providers, Energy Consulting, Facility managers, EE Building construction &refurbishment companies, ESCOs, Utilities…	**ISA**, ISEP, Acciona, Mostostal, D'Appolonia, Nobatek *CSTB in house*	Ownership or EPC models: direct contract for design, installation, commissioning and maintenance. Technology transfer & licenses to others outside the consortium	Direct service through own sales network Other sales networks	ISA-ISEP-Mostostal/ all partners
3.Project, supply, installation, commissioning and maintenance of Energy consumption and comfort monitoring infrastructure (metering…) mainly based on ISA metering equipment (deployed in Zaragoza and Genova pilot sites)	Infrastructure available in the market	Public and Private Social housing building owners. Private building owners. ICT solutions &BEMs providers, Energy Consulting, Facility managers, EE Building construction &refurbishment companies, ESCOs, Utilities…	Project ISA /Acciona-Nobatek. D'Appolonia Supply, installation, commissioning and maintenance: ISA/all *CSTB in house*	direct contract(s) through ownership model Technology transfer & licenses to others outside the consortium	ISA:Sales through their own sales network Others: own sales network	Project:ISA-Dapp, Acciona, Nobatek, Mostostal. Supply:ISA Installation, commissioning and maintenance:

Product/service description	Maturity/Time to market	Application sectors/customers	Partners developers / Other partners for exploitation	Business models associated	Routes for exploitation	IPR- Owner(s)/ Right of use in favourable conditions
						Free
4.E3Soho ICT solution integrating a communication processing and storage plaform (iEnergy) and user interfaces for tenants and owners /managers sDisplay or VAS / BMUI	Stable and tested prototype/6months. Simplified solutions for affordability	Public and Private Social housing building owners. Private building owners. ICT solutions &BEMs providers, Energy Consulting, Facility managers, EE Building construction &refurbishment companies, ESCOs, Utilities…	ISA, ISEP, Acciona, Mostostal, Nobatek D'Appolonia, *CSTB in house*	Ownership model: for design, installation, commissioning and maintenance. Technology transfer & licenses to others outside the consortium	ISA: Through their own sales network Others' sales networks	
5.-iEnergy Platform - a communication and data processing platform : web interface for remote monitoring, configuration, maintenance and data analysis in E3SoHo building module for aggregation and processing of data received from iEnergy Communication Module or through web services, offering a unified interface for development of user interfaces	Ready to market *(It normally should be marketed together with the iEnergy platform)*	Public and Private Social housing building owners. Private building owners. ICT solutions &BEMs providers, Energy Consulting, Facility managers, EE Building construction &refurbishment companies, ESCOs, Utilities…	ISA/Acciona-ISEP Mostostal- Nobatek D'Appolonia, *CSTB in house*	Ownership model	ISA: Through their own sales network Others' sales networks	ISA/ all parrners
6.-sDisplay: ICT Graphical User Interface (web application and Android native application)	Stable and tested prototype. Android native application ready to	Public and Private Social housing building owners. Private building owners. ICT solutions &BEMs	ISA/Acciona-Mostostal-Nobatek	Ownership model:	ISA: Through their own sales	ISA/ All partners

Product/service description	Maturity/Time to market	Application sectors/customers	Partners developers / Other partners for exploitation	Business models associated	Routes for exploitation	IPR- Owner(s)/ Right of use in favourable conditions
providing energy consumption visualization, awareness and alerts for the tenants and building owners/managers	market. Could be adapted to more recent versions of Android, and/or different types of devices:smartphones, TV.)/6months.	providers, Energy Consulting, Facility managers, EE Building construction &refurbishment companies, ESCOs, Utilities…	D'Appolonia *CSTB in house*		network Others' sales networks	
7- Building managers(BMUI)' application: web application developed as a social housing owners' and managers' tool	Prototype/6months	Public and Private Social housing building owners. Private building owners. ICT solutions &BEMs providers, Energy Consulting, Facility managers, EE Building construction &refurbishment companies, ESCOs, Utilities…	ISA/Acciona-ISEP Mostostal- Nobatek D'Appolonia *CSTB in house*	Ownership model	ISA: Through their own sales network Others' sales networks	ISA/ All partners
8. Project , supply, installation, commissioning and maintenance of. Energy generation metering infrastructure (…) mainly based on ISA equipment (deployed in Zaragoza pilot site in solar panels for DHW production)	Infrastructure available in the market	Public and Private Social housing building owners. Private building owners. ICT solutions &BEMs providers, Energy Consulting, Facility managers, EE Building construction &refurbishment companies, ESCOs, Utilities…	Project:ISA/Acciona-Nobatek Supply, installation, commissioning and maintenance: ISA-other providers /all *CSTB in house*	Design: consulting service. Installation, commissioning and maintenance: direct contract Technology transfer & licenses to others outside the consortium	ISA: Through their own sales network Others' sales networks	Project:All Supply:ISA Installation, commissioning and maintenance: Free

Product/service description	Maturity/Time to market	Application sectors/customers	Partners developers / Other partners for exploitation	Business models associated	Routes for exploitation	IPR- Owner(s)/ Right of use in favourable conditions
9. E3SoHo Polish solution composed by VAS – Visualization and Alert System: for the tenants and Polish data base specification for Polish data collection and storage	Stable and tested prototype/6months. Simplified solutions for better affordability	Public and Private Social housing building owners. Private building owners. ICT solutions &BEMs providers, Energy Consulting, Facility managers, EE Building construction &refurbishment companies, ESCOs, Utilities…	ISEP – Mostostal / Acciona-D'Appolonia-ISA--Nobatek *CSTB in house*	Ownership model: direct contract for design, installation, commissioning and maintenance. Technology transfer & licenses to others outside the consortium	ISEP –Mostostal: Through their own sales network/ spin-off Licensing. Others´ sales networks	ISEP – Mostostal/All partners
10-VAS – Visualization and Alert System: ICT Graphical User Interface (web application) providing energy consumption visualization, awareness and alerts for the tenants	Stable and tested prototype. It ormally should be marketed together with the iEnergy platform or the Polish data base *In some cases individually marketed is possible providing could be integrated with other platforms*	Public and Private Social housing building owners. Private building owners. ICT solutions &BEMs providers, Energy Consulting, Facility managers, EE Building construction &refurbishment companies, ESCOs, Utilities…	ISEP -Mostostal / Acciona-D'Appolonia-ISA—Nobatek *CSTB in house*	Ownership model ISEP-Mostostal: Software direct sale to user-licensing. Other partners: direct sale to user	ISEP –Mostostal: Through their own sales network/ spin-off Licensing. Others´ sales networks	ISEP – Mostostal/All partners
11.Polish data base specification for Polish data collection and storage	Stable and tested prototype./6months	Public and Private Social housing building owners. Private building owners. ICT solutions providers, Energy Consulting, Facility managers, BEMS providers, EE	ISEP -Mostostal / Acciona-D'Appolonia-ISA—Nobatek *CSTB in house*	Ownership model ISEP-Mostostal: Direct sale to user-licensing.	ISEP –Mostostal: Through their own sales network/ Licensing. Others	ISEP – Mostostal/All partners

Product/service description	Maturity/Time to market	Application sectors/customers	Partners developers / Other partners for exploitation	Business models associated	Routes for exploitation	IPR- Owner(s)/ Right of use in favourable conditions
		Building construction & refurbishment companies, ESCOs, Utilities…		Other partners: direct sale to user	:through their own sales networks	
12.Data migration system from Polish or other data base to iEnergy	Stable and tested prototype./6months	Public and Private Social housing building owners. Private building owners. ICT solutions providers, Energy Consulting, Facility managers, BEMS providers, E E Building construction&refurbishment companies,ESCOs Utilities	ISEP -ISA / Acciona-D'Appolonia-ISA-Nobatek *CSTB in house*	Ownership model ISEP-Mostostal: Direct sale to user-licensing. Other partners: direct sale to user	ISEP –Mostostal: Through their own sales network/ Licensing. Others :through their own sales networks	ISEP – Mostostal/All partners
13 Project , supply, installation, commissioning and maintenance of Energy consumption and comfort monitoring infrastructure based on PLC and wired/wireless sensors/meters from different vendors installed in Poland	Infrastructure available in the market	Public and Private Social housing building owners. Private building owners. ICT solutions providers, Energy Consulting, Facility managers, BEMS providers, E E Building construction&refurbishment companies,ESCOs Utilities	Project:ISEP-Mostostal/all Supply, installation, commissioning and maintenance: ISEP-Mostostal-other providers /all	Design: consulting service. Installation, commissioning and maintenance: direct contract Technology transfer & licenses to others outside the consortium	ISA:Direct sales through their own sales network/ Others: through their own sales networks	Project:All Supply:Mostostal Installation, commissioning and maintenance: Free
14. Social innovation	Tenants behavior	Tenants	all	Consulting services	All partners: through their own sales	All

Product/service description	Maturity/Time to market	Application sectors/customers	Partners developers / Other partners for exploitation	Business models associated	Routes for exploitation	IPR- Owner(s)/ Right of use in favourable conditions
					networks	
15. User awareness training	Courses have been prepared	Tenants, building owners	all	Training services	All partners: through their own sales networks	All

Grouping products and services

The exploitable products and services identified in the project and listed in the table above may be offered to the market under **7 different structured** categories of products /services:

A. **Consultancy services** could be provided as standalone services and could be customized based on the reference context. They are not only ICT related.
B. **ICT Solution–infrastructure**: encompass the product and services needed to build the platform for collection and analysis of data. This infrastructure may encompass the collection of data from energy generation if this type of infrastructure is present in the building. The smart meters and sensors integrated in the infrastructure may be supplied by ISA or by external suppliers.
C. **ICT Solution–infrastructure + tenants services** – as B + the services customized for tenants. Services include the dedicated user interfaces for tenants (either sDisplay or VAS) and specific training, monitoring and awareness services.
D. **ICT Solution–infrastructure + tenants services + managers' services** – as C + the services customized for building owners/managers (including dedicated user interfaces, such as the BMUI).
E. **Project, supply, installation, commissioning and maintenance:** development of customized project, supply, installation, commissioning and maintenance services.
F. **Full ICT solution (D+E)** it encompasses the ICT solution + the services for tenants + managers services + development and maintenance of overall infrastructure.
G. **Full solution with consultancy (A+F)** services encompasses all the 15 Exploitable products and services identified.

SWOT ANALYSIS

The SWOT Analysis has been applied to the E3SoHo ICT solution, as shown in the table below:

STRENGHTS	WEAKNESSES
- Evolved versions of the ICT solution can reduce significantly the costs of the equipment needed - Disruptive design product. - Innovative features, such as real time data independent of the interface, among others. - Based on partner's experience in smart metering - Large client portfolio of some partners - Cloud based approach to data and platforms. - Capacity of developing our own SW and our own HW. - More interoperable than competitors in general: one single data communication and processing platform successfully tested for three pilot sites. - Flexibility to integrate smart meters and sensors from different vendors, which enables the contracting of local suppliers or measurement equipment. - Solution tested in several pilots with user acceptance validated through social housing organizations participating in the consortium - Improved know-how for design, implementation and monitoring, based on lessons learnt in the project	- Simple and poor algorithms within the product for the presented values and calculations that will be soon improved. - Lack of previous experience of some partners in the B2C market, therefore they do not have particular experience in selling this kind of ICT solutions. - Internet dependency which is difficult for several collectives. - Need to be adapted to new interfaces (applications optimized for smartphones, TV…) - Uncertainty of rate of savings that will be achieved, which makes it difficult to assess payback periods and return on investment.
OPPORTUNITIES	**THREATS**
- The market is huge. - There are market and policy drivers for implementation. - Not many competitors in Europe that could offer similar services. - Recurring increments in energy prices - European Smart Meter deployment undergoing. - Internet connection is growing among potential future customers. - Internal exploitation feasibility of our social housing partners - Several Routes to market and business models to be applied	- Financing barriers for customer not easy to overcome. - Low income customers in the case of social housing - Potential lack of engagement of the customers in the use of the tool - No perception of the effective savings due to the use of the tool. - Lack of credibility of this kind of products. - Undifferentiated perception of the product when compared to the competitors. - Competence from substitute products (cheaper, better quality…) - Low product margin due to small order productions.

Energy savings in the Pilots

The table below shows the summary of the total energy consumptions of the 16 dwellings of Zaragoza pilot site, and the average savings achieved for each type of consumption, and for the global energy consumption. We consider the savings in heating consumption corrected with HDD, as this is the methodology most commonly accepted.

ZARAGOZA							
	Annual consumption (baseline period)			**Annual consumption (monitoring period)**	**Savings**		
Heating (kWh)	Real	Corrected			Without HDD correction	With HDD correction	
	40.075	41.940		37.591	6,20%	10,37%	
DHW (m3)	Real	Corrected			Without HDD correction	With HDD correction	
	593	645		613	-3,37%	4,96%	
DHW (kWh)	Real	Corrected			Without HDD correction	With HDD correction	
	17.078	18.576		17.654	-3,37%	4,96%	
Electricity (kWh)	34.969			32.224	7,85%		
Total (kWh)	Without corrections	Corrected Heating	Corrected Heating + DHW		Without corrections	**With corrected Heating**	With Corrected Heating + DHW
	92.122	93.987	95.485	87.470	5,05%	**6,93%**	8,39%

The table below shows the summary of the total energy consumptions of the 16 dwellings of Warsaw pilot site, and the average savings achieved for each type of

consumption, and for the global energy consumption. We consider the savings in heating consumption corrected with HDD, as this is the methodology most commonly accepted.

WARSAW							
	Annual consumption (baseline period)			Annual consumption (monitoring period)	Savings		
Heating (kWh)	Real	Corrected			Without HDD correction	With HDD correction	
	39.891	40.463		36.423	8,69%	9,98%	
DHW (m3)	Real	Corrected			Without HDD correction	With HDD correction	
	393	404		421	-6,99%	-4,18%	
DHW (kWh)	Real	Corrected			Without HDD correction	With HDD correction	
	24.784	25.452		26.517	-6,99%	-4,18%	
Electricity (kWh)	15.141			14.842	1,97%		
Total (kWh)	Without corrections	Corrected Heating	Corrected Heating + DHW		Without corrections	**With corrected Heating**	With Corrected Heating + DHW
	79.816	80.388	81.056	77.782	2,55%	**3,24%**	4,04%

The case of Genoa

In Genoa we used a control group for comparing the consumption of the dwellings with the full ICT solution (i.e. tenants provided with graphical user interface for receiving information about energy consumption and personalized advices),and the ones belonging to the control group (dwellings with metering infrastructure only, with no graphical user interface provided to the tenants).

The control group methodology, which was the only possible in the pilot due to late incorporation to the project and unavailability of data from energy bills, has proved problematic.

Pairs of dwellings from the control and monitoring group, which were in theory similar, have actually had very disparate ranges of energy consumption.

Control group may work with much bigger samples of dwellings, but in general is preferable to use comparison with baseline defined with energy bills and/or measurements

As a result, savings in the pilot site could not be assessed properly by comparing the two groups, except for a reduced number of dwellings which had energy bills available.

A small group of 4 dwellings was analysed comparing baseline with monitoring periods, and the results were an average saving of 1.8% in electricity

6 Conclusions and lessons learnt

Conclusions and lessons learned have been derived by all the members of the consortium from all the phases of the project, from its conception to its finalization. We include here some of the most important.

Preparing the proposal/project

- The active participation of social housing providers (owners) as partners is absolutely necessary from the pilot conception, mobilization of tenants, to the impact analysis and further replication
- Tenants voluntary involvement is a key necessity for the success of the project
- Local partners around the pilots are fundamental to support the social housing providers and tenants
- The selection of the pilots themselves is a key issue before starting a pilot project. An energy efficiency audit before starting is convenient for an initial check of the energy savings potential of the building.
- It is very recommendable, if possible, to incorporate utilities as partners or have a collaboration agreement with them to develop this kind of projects, if they have already a smart meter deployment in the pilot buildings which could be used to obtain consumption data reducing the need to install additional equipment.
- A larger number of tenants than the total who were directly involved in the project is desirable in order to avoid distortion factors such as change of tenants within a dwelling, prolonged absence of tenants, etc. Furthermore, if a control group approach is planned, the sample must be large enough to allow statistically significant comparisons with the monitoring group.
- A larger duration of the project is recommended (about 4 years, instead of the usual 3 years), mainly because the pre-monitoring period and the monitoring period should last at least 12 months each, which leaves only another 12 months for requirements analysis, solution design and testing, evaluation of results, etc., which is a too short period.

Performing the project

Social &acceptance issues

- We have got a better understanding of actual behaviours of social housing tenants towards energy efficiency, being cost savings the biggest motivation
- We have acquired knowledge about stakeholders (v.i. maintenance companies) that should be involved in a way during the lifecycle of the project
- Building owners/managers could and should play here a key role in optimizing their management strategies and for changing tenant behaviours towards energy efficiency
- Providing a specific tool for building owners answers a real demand from their side to improve buildings management, and have an impact on the consumption of tenants.
- Users' acceptance in terms of user interface friendliness, accurateness of the information provided, and credibility of the ICT technologies implemented is key in changing their behaviours.
- Although the tenants are not massively convinced of the efficiency of the E3SoHo solution, they can soon change their mind if we ease the application usability, and if we are able to demonstrate effective results. Written information is appreciated as a complement.
- Higher success of Android native applications as tenant user interface (tablet, smartphone) than the web application because it is easier to use for any kind of user.
- The use of this new technology continues to be complicated for some sectors of the population: elderly people, foreign people. It would be convenient to develop specific communication means adapted to the elderly (e.g. television).
- Tenants are quite satisfied with the solution considering functionalities, interface, and installation process (even if they got technical problems, mainly on connection issues)
- Training sessions are fundamental for end users involvement, for understanding the tools provided, and for changing behaviours.
- Awareness campaign and training tools (e.g. bulletins, written instructions) are very positively assessed by the users.

Technical issues

- Development of a global methodology for design, implementation and monitoring, including guidelines for replication is a key factor.
- We have been able to test and implement successfully an interoperable solution integrating devices and tools from different vendors.
- Monitoring and evaluation including the definition of a baseline starting point and targets to be achieved, are key to understanding the economic feasibility of the ICT solution, and to making necessary adjustments to improve its impact.
- We have identified common problems in the different pilot sites associated to ICT solution design, deployment and verification like: meters, calibration, communication, availability of invoices, and have learnt about how to do it better in the future and avoid repeating the same mistakes.
- Standardization and interoperability among different equipment manufacturers are also key enablers for exploitation. E3SoHo has taken these factors into account in order to design an ICT solution capable of integrating different metering equipment, software modules, and with interoperability with 3rd party systems, such as Building Management Systems.
- Communication and batteries are among the main issues with actual technologies. Compatibility with existing counters, existing meters or existing communication systems, even if supported by the solution, can also be tricky and should be addressed.
- Design of appropriate communication networks is a critical point for a fully operative working solution.
- The implementation of electrical sub metering through smart plugs should be carefully assessed, as the experience of the project shows that the collected data may be difficult to analyse due to communication problems. However, if we consider that the replicated ICT solution will rely on the Internet connection of the tenants, these implementation problems should not appear.
- The use of window opening sensors does not provide enough added value information that could compensate the increase in the costs of the ICT solution and the complexity of the installation.
- Control of occupancy is an independent parameter that needs to be monitored to properly evaluate savings, and it can also be exploited to assess some behaviours, such as the management of heating. However, the experience of the project reveals that data from presence sensors are very difficult to interpret, and therefore the increase in costs and complexity advices against

the integration of this kind of sensors in the ICT solution.

- The capacity of the monitoring system to automatically detect errors and to evaluate the accurateness of the treated data (i.e. missing data or data indicating a wrong value) should be reinforced in order to improve the trustability of the data collected through the ICT solution. This is an important issue as it impacts both uses of the data collected: for information display to the tenants and for the project monitoring purpose
- For further projects and for further commercial activity in foreign countries it showed that local technical representation is an important plus to ensure implementation quality and quick reaction to technical incidences.
- It may be a good opportunity in further projects and commercial systems to get automatically feedbacks from the tenants via the ICT display itself. It would allow to generate more interactivity and to get more detailed information about satisfaction/non satisfaction with the system. In terms of monitoring it would strongly help in understanding the intensity of tenants' use of the systems

Energy savings strategies & Potential

- Necessity of targeting the reduction of peak loads in order to reduce the cost of the energy supply and reduce the emissions.
- Summer efficient comfort management strategies are needed in Zaragoza and Genoa (comfort in warm climates) to avoid or to reduce of air conditioning (through the use of blinds, optimal windows management)…
- High levels of residual consumption detected (consumption on stand-by) and should be addressed to train tenants on its importance and on how to avoid it.
- Important energy savings opportunities (potential) detected in the three pilots: From the large discrepancies between dwellings in consumption profiles of similar dwellings (in terms of surface occupants and from indoor temperature levels (pre-monitoring).
- Difficulties for ICT system evaluation: savings are on the same range as "natural evolutions" or typical saving measures, or influence of the awareness itself
- In Zaragoza and Warsaw pilots a reasonable level of savings have been achieved
- We have realized about the real costs of ICT solution deployed and how to simplify it to make it economic feasible for of its replicability and exploitation

Feasibility of investment

- Prior to the investment it is necessary to carry out at least a quick audit in order to assess the possible savings to be achieved, combining traditional retrofitting actions with the use of ICT awareness tools.
- The feasibility of an investment in an ICT solution for energy efficiency depends on a wide variety of factors, such as: structure of energy bills (e.g. fixed vs. variable costs), the actual or expected consumption levels, features of the building, users' profiles, etc.
- The ICT solutions developed in E3SoHo project and further segmentation, and the trend of cost reduction in the supporting technologies (smart meters, interfaces, communication equipment…) could allow the provision of affordable solutions that can be amortized in a reasonable period.
- Low energy savings percentages at building level (less than 7%) are required in order to obtain payback periods shorter than 5 years with the investment on the specific solution for building managers, although it will be necessary to consider also the cost of any automation or refurbishment that could be necessary to achieve the savings or even to increase them.
- Addressing the ICT solution to those that are high energy consumers (especially in electricity) facilitates a shorter payback period and higher ROI.
- The history of increasing price of energy, both electricity and thermal, as well as the future forecast is the main driver for energy efficiency and energy savings and can facilitate the implementation of the ICT solution.
- Political drivers are needed to improve financial opportunities through strengthening the regulatory framework for energy efficiency to stimulate more and more effective investments, improving access to financing, addressing market failures, and strengthening the energy market services.
- The use of particular instruments in the social housing sector like: an aggregation hub for low-carbon finance, the pooling of expertise and skills through the development of clusters of actors, and the continuation of applied research to develop low-cost technologies for the improvement of energy efficiency in social housing.
- The smart meters roll-out and the increased use of internet can reduce the cost of the investment.
- Traditional business models such as ownership model (direct purchase of the system by the owner can be applied), but also energy performance contract model for services are envisaged.

Market & Competitors

- The market of social housing (public and private social housing providers, dwelling owners and tenants) that can buy the E3SoHo ICT solution is huge. Furthermore the solution can be extended to any type of housing, which makes the market even much larger. The ICT solution can be marketed through other intermediaries such as: Energy efficiency general contractors, ICT solutions & BEMs providers, ESCOs, Utilities, etc.
- There are a good number ICT tools providers for energy consumption awareness and management (including control) at building level, namely for commercial and public buildings, but the solutions for energy consumption awareness at dwelling level, targeting individual consumers, are still in the early phases of their development.
- There are a number of competitors around the world, most of them SMEs that are already offering several solutions with apparently similar functionalities than E3SoHo, coming especially from France and UK, in the case of Europe. There is still a majority of European countries without local provider(s). Other competitors will appear soon as a result of other European sister ICT PSP projects.
- Many companies are operating in a single country or are at least focused on a specific geographic area. Probably the singularity of the energy systems (e.g. type of electricity plugs) across different countries and regions is an explanation for this market fragmentation.
- From the public information available in their respective websites, the information regarding the cost of commercially available ICT solutionsis in general very poor, as well as the examples provided of implemented projects. Most solutions do not have a clear differentiation from their competitors.
- The channels for commercialization of the products can be very different from one company to another. Some companies sell their products directly to the residential customers, in some cases products can be directly purchased online, and in other cases products are not sold directly to the residential users, but through intermediaries such as utilities and energy management companies
- It looks like the solutions are not widely deployed yet. None of these providers is specifically addressing social housing. It is very difficult to evaluate the technical quality of the product service without testing them. In the majority of the cases there is a lack of information about interoperability
- To sum up, in order to be successful in the ICT for energy efficiency market, E3SoHo partners should look for geographic areas where similar products and solutions are less widespread, highlight key differentiation aspects of the

E3SoHo solution compared to its competitors, and identify the most efficient channels for commercialization for each geographic area addressed

Strategy for commercialization

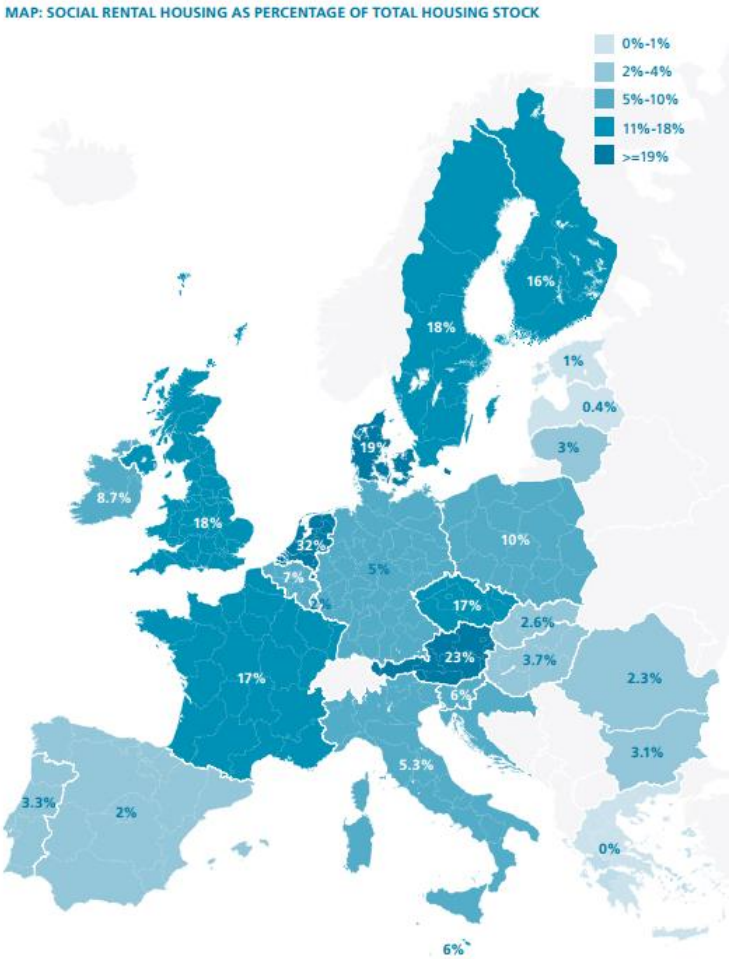
- A combination of internalization, externalization, spin-off, cooperation with other ICT solutions developers and research and development has been selected that gives a wider opportunity for exploitation.
- Grouping services together with the position of the partners as the main stakeholders of the value chain and the outline of global and individual exploitation strategies facilitates the exploitation.
- Intensive awareness and dissemination campaigns in Europe are necessary for a rapid introduction of this type of products and service addressing different collectives (social housing organizations, users, ESCOs, Utilities…), namely by ISA, because the product services will be commercialized mainly by ISA under the E3SoHo brand.
- The ICT based energy awareness tools and their associated services could be marketed alone or to be included in a package together with other existing services for new buildings or retrofitting
- Identification of local stakeholders for supply of small ICT parts or maintenance and communication services even if not directly part of the project (acting as subcontractors). Moreover they can be potential stakeholders to be involved in the future business model of the project;
- Deep involvement of owner of the building is a key aspects since they: have deep knowledge on household profile; are involved in the identification of dwellings– who can/should be included in the monitoring group are the interface with ICT solution providers if problem arise Can be the first advisors of anomalous behavior of tenants through the monitoring of data on i-energy platform.
- In the case of existing buildings with an owner and rented tenants, the commercialization will be easier if the owner decides to install the system and pay for it. Other models such as sharing costs shall be explored.
- In both cases, for new and existing buildings, with individual owners/tenants, the ICT solution can be sold directly to owners/tenants.
- IPR issues among the partners shall be clearly defined together with a specific definition of products/services to be exploited, time to market, targeted customers, routes for exploitation and associated business models.
- Ideally, the installation of the ICT solution should be decided in the design phase of new buildings, and thus be integrated in the original equipment of

the building. For that purpose, appropriate actions with the prescriptors (architects, engineers and owners) should be undertaken

7 Potential impact and use

7.1 Socio-economic impact

The ICT solution can have an important socio-economic impact. From one side the large number of social housing tenants and social housing buildings that can benefit in different ways from the implementation of the ICT solution in terms of energy savings, and then direct economic savings, while maintaining comfort and reducing the CO_2 footprint. Furthermore the deployment of such kind of solutions/services can produce the creation of quality jobs and economic growth especially among SMEs. The social housing market represents about 12% of the total housing market. Furthermore the ICT solution can be deployed in the general housing sector.



Considering that the total buildings stock in Europe represent about 40% of the energy consumption and 30% of the CO2 emissions. Housing represents about 26.6% of the total consumption of buildings and contributes with around 20% of emissions.

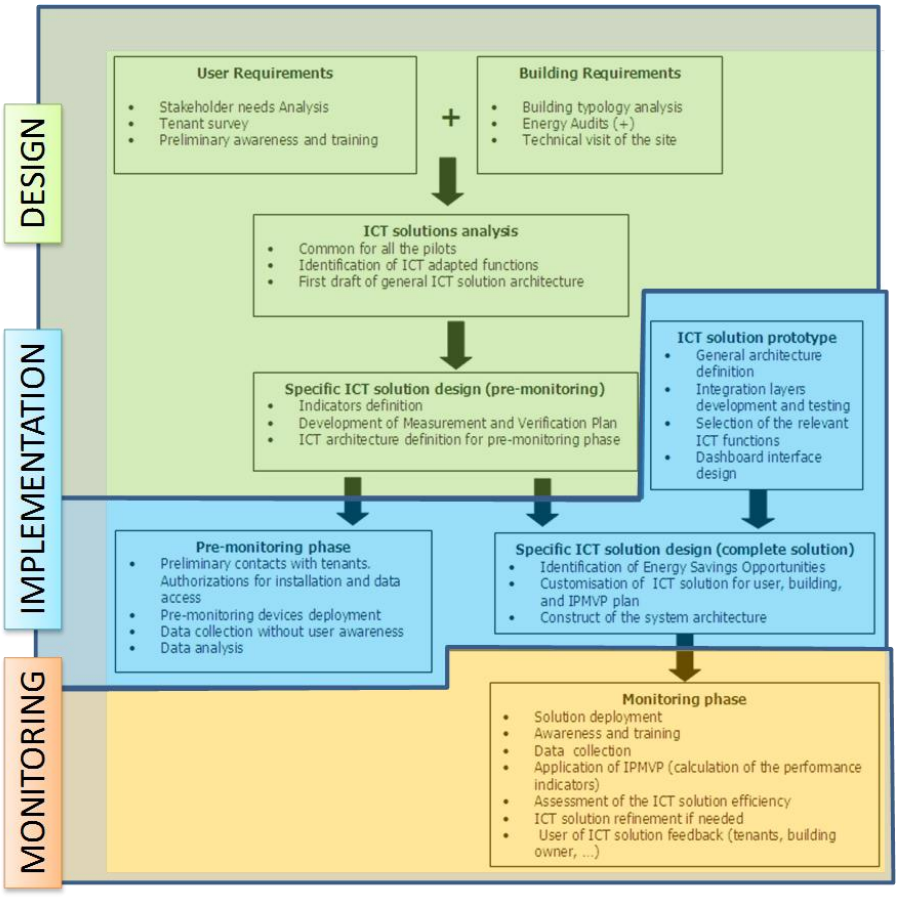
A saving in energy of only 5% due to the E3SoHo solution will contribute then to the saving of 1.33% of total energy demand and 1% of CO_2 emissions.

A specific replication plan within the next 5 years has been outlined for the social housing providers: Zaragoza Vivienda, City of Warsaw and Comune di Genova

7.2 Methodology and guidelines for replication

The global methodology developed by E3SoHo aims to promote replication beyond the pilot buildings and countries covered by the project, encouraging other stakeholders in other countries to adopt the defined strategy or, alternatively, to adapt and integrate it into their own methodologies.

The figure below presents the three phases of the E3SoHo methodology, starting from the design to the monitoring, passing through the implementation. The lessons learnt during the real implementation of such methodology gave to the consortium important hints on how to customize it on different environments and how to make it more flexible and adaptive to different contexts.



Items of special interest to highlight in the figure above are the following:

- The methodology begins and ends with the client (building owners/managers and tenants), from the analysis of requirements to the assessment of users' acceptance of the solution;
- The methodology is a process that customizes ICT solutions for tenants, building owners/managers, and other stakeholders' needs;
- Energy audits are marked with a (+) because it is recognized that an audit with the intent of designing ICT solutions needs to include different aspects than what is typically conducted/reported using only EPBD as a guideline;
- The project uses a "pre-monitoring" phase to characterize the baseline;
- IPMVP appears in two different places, the development of a measurement and verification plan, and then the calculations and assessment of energy savings;
- Awareness, training, and engaging stakeholders and tenants is present throughout the methodology to trigger and sustain changes in users' behaviour.

Main highlights of the methodology for design

The first methodology step (methodology for design) is the design of the overall ICT system, taking into consideration specific requirements of users and of the building, technical and non-technical constraints or limitations and available resources. The methodology for design encompasses the following aspects:

- ***Users' requirements:***
    - *Stakeholders' needs analysis*: In the very preliminary step, it is crucial to clearly identify who are the involved stakeholders (building owners, buildings managers, utilities, etc.) and how they interact, among them and with the tenants.
    - *Tenants' survey*: At the beginning of activities, a survey shall be conducted with the tenants, in order to extract user requirements for the definition of the ICT solution: profiling of tenants, collection of billing information, familiarity with ICT, current habits related to energy consumption, etc.
    - *Preliminary awareness and training:* Preliminary explanation to the tenants of the plans for the installation of the ICT solution is crucial for several reasons, as the E3SoHo experience revealed, in order to promote since the beginning positive attitudes towards habits

improvement, and to increase the acceptance of the solution which will be implemented.

- ***Building's requirements***

  - *Building typology analysis:* This methodological step consists of identifying the typology of the building and specifies the requirements and constraints impacting the design of adapted ICT solutions (Region, climate, typology of dwellings, living surface, etc.).

  - *Energy audit:* In the specific framework of this methodology, a Level 1 audit – Simple Audit is recommended: a remote investigation of the dwellings using past energy invoices, tenants information, equipment inventories, and usual occupation of the dwelling.

  - *Technical visit to the site:* The aim of the technical visit is to get a clear picture of the environment where the ICT solution will be implemented and, in particular, to get evidence of possible installation, structural or architectural limitations that have been not noticed before.

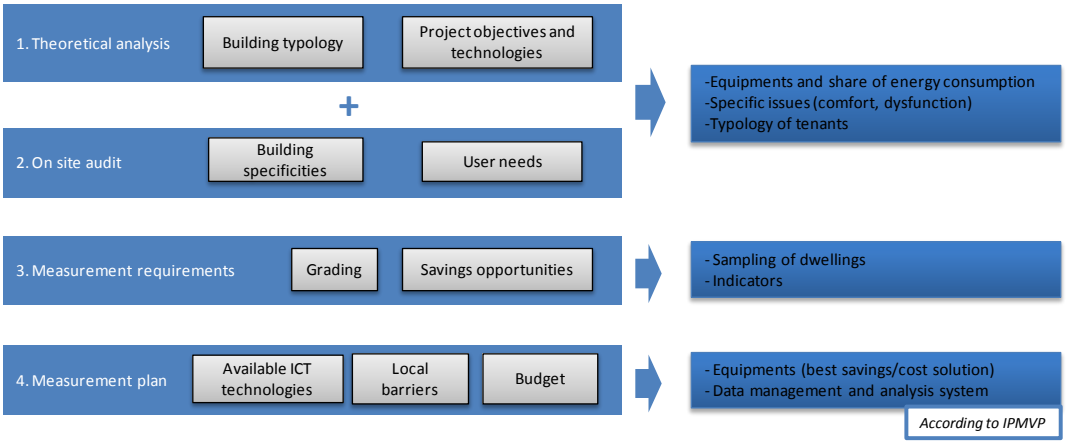
- ***ICT solution design***

  - *ICT solution analysis:* The next methodological step is to analyze the collected requirements of the pilot and the report after the technical visit, for identifying the installation constraints that have an impact on the design of the ICT infrastructure which will be used for the pre-monitoring phase, upon which the full ICT solution will be later built up. The main outcome of this step is a diagram block, linked to a tentative and cost-effective ICT solution.

  - *Indicators definition:* Following a top-down approach, a list of indicators shall be defined, with a two-fold purpose: for the identification of indicators to be shown on tables/charts as part of the ICT solution, and for evaluation of the efficiency of the ICT solution and awareness actions with regard to energy savings achieved.

  - *Development of Measurement & Verification Plan:* The International Performance Measurement & Verification Protocol (IPMVP) defines standard terms and suggests best practices for quantifying the results of energy efficiency investments. IPMVP Volume 1 suggests a 13 step planning process, which have been simplified and synthesized in four steps, according to the figure below, as a way to organise the completion of the M&V plan for social housing and in general for any

energy efficiency project. This initial plan will be the basis for the last step of the methodology: the methodology for monitoring.



- *Architecture definition for pre-monitoring phase:* This phase brings to the specific ICT solution design for pre-monitoring, considering the particular requirements for the pilot once the general ICT solution prototype development is finished. This phase consists of the following concrete actions: prototype particularization, gathering of technical offers, and definition of the ICT specific solution for pre-monitoring.

Main highlights of the methodology for implementation

The second methodology step (methodology for implementation) consists of the following aspects:

- ***Pre-monitoring phase:*** this step deals with the implementation in the pilots of the ICT specific solution for pre-monitoring which was defined at the end of the methodology for monitoring. The actions included in this step are: preliminary contacts with tenants and gathering of necessary authorizations; deployment of pre-monitoring devices; data collection without user awareness actions (preferably for 12 months at least), and pre-monitoring data analysis.

- ***ICT solution complete prototype:*** construction of the ICT solution complete prototype, implementing the advanced functionalities (user interfaces for tenants and building managers, smart alerts management, etc.) on top of the ICT solution for pre-monitoring defined in the previous steps.

- ***Specific ICT complete solution:*** second step of the deployment, installing the specific ICT complete solution on top of the pre-monitoring solution already available in the pilot.

Within the Methodology for implementation (D6.2) an analysis at pilot level was developed. The pilots have been presented as individual case studies, gathering for

each of them the implementation specific aspects which have been considered and settled up. Therefore this analysis provides the methodological steps conducted at each of the three E3SoHo pilot sites; for each pilot an analysis in terms of key partners involved, key activities, key resources, value proposition, channels, costs and lessons learned was performed. The analysis of the pilots as individual case studies should be checked for any future replication in order to learn the lessons of the project and carry out successfully any implementation of an ICT solution for energy efficiency within a social housing context.

Main highlights of the methodology for monitoring

The last step is the monitoring phase, in which the results obtained during the monitoring period (i.e. period in which the complete ICT solution is running in the pilot, at least for 12 months) in terms of energy savings and behaviours evolution will be assessed. The following aspects shall be considered:

- ***Specification on measurement, metering and monitoring:*** monitoring in the field of ICT for energy efficiency in buildings defines the whole process of evaluation of performance, from the point of view of generation of information for the building users, and of the assessment of the ICT solution implemented in the pilot site. Measurements refer to the process of collecting raw data using hardware tools, mainly meters and sensors, or through energy bills collection. Metering refers to the counting process of the consumption of energy and fluids in the buildings, complementary to the information gathered from other types of sensors (e.g. temperature and humidity).

- ***Overall strategy:*** The monitoring strategy, mostly derived from the IPMVP protocol, is based on the following approaches:

    - *Size of the sample:* address an intermediate number of dwellings

    - *Multi-level analysis:* year-to-year comparisons, but also seasonal analysis, typical week, typical day, etc.

    - *Multi-source data:* combination of measurements and energy bills

    - *Two approaches for evaluation:* comparison of reference period – baseline period, or use of control group.

    - *Definition of indicators for different aims:* raw data, first level indicators, opportunity indicators

    - *Definition of adjustment methods* (e.g. HDD for heating consumption)

- *Setup of a plan for user behaviour evaluation:* based on regular interviews of the tenants about their use of the ICT system and their own behaviour perception

- ***Indicators:*** most important indicators to consider are:

  - *Energy related indicators:* Energy consumption per type of energy: gas, electricity; and energy consumption per usages: heating, DHW, lighting, electrical appliances

  - *Comfort indicators:* Indoor temperature; Number of hours above 28°C in the dwellings (for summer period)

  - *Progress indicators:* Global energy consumption (and savings) indicators and progress indicators (e.g. average of individual savings) to assess the efforts realized by tenants, independently of their initial level of consumption

- ***Analysis procedure and results calculation:*** Indicators shall be evaluated relatively to their context (exterior temperature, dwellings areas, occupation rate) and to specific periods (warm and cold season, typical week, etc.), with the relative evolution between the reference period and the monitoring period (in % relative to the reference period).

- ***Influencing factors and adjustments calculation:*** The influencing factors and adjustments done are in line with the ones integrated in the common methodology of ICT PSP projects and the eeMeasure tool for evaluation of savings.

7.3 Lessons from the E3SoHo Methodology: Installation, operating and monitoring experience

From the observation realized between initial methodology and pragmatic implementation on site, the main lessons learned about monitoring practices are presented hereafter.

- ***Specificity of evaluating the impact of ICT systems:*** Energy savings generated by ICT systems are moderate to low, compared to the impacts generated by envelope improvement or modification of HVAC systems in the buildings. This leads to a modest, but very interesting compared to the initial investment, level of savings which are generated by behavioural changes only. These savings are particularly difficult to detect, within the global flow of behavioural evolution one may observe in the "normal life" of a dwelling. The E3SoHo experience indicates that it requires further research on methodological aspects, regarding

behaviour evolution and monitoring of these evolution, to generate new tools and give the opportunity for better assessment of such phenomena.

- ***Size and representativeness of the sample of dwellings:*** sample size in E3SoHo was defined as a compromise between the need to have representative dwellings and the affordability of the project. However, it appeared that even if the dwellings were selected cautiously to be representative of the whole building in each site, the samples were too small and then largely dependent on minor variations in energy behaviour of only one dwelling in the sample. It is necessary to control additional parameters of the dwellings which were considered initially as static parameters, such as occupation and number of people in the dwellings at certain periods.

- ***Monitoring strategy:*** E3SoHo has used two main monitoring strategies: monitoring on the same group of dwellings/families, before and after the implementation of the ICT solution; and comparison of two different groups (monitoring and control group) of dwellings for one site, one with the technology and the other without, observed during the same period. The control group strategy revealed the need of much larger samples of dwellings to be meaningful in the case of ICT based projects. With regard to the reference period, data treatment showed the importance of having a consolidated baseline very soon and at this moment to identify the issues that might occur during the reporting period, in terms of quality of data and exploitation process, in order to be able to anticipate such difficulties

- ***Monitoring plan:*** The choice of sensors is critical in order to achieve the right balance of usefulness, cost and dweller inconvenience. A lesson therefore is to devise beforehand what are the required sensors and make sure their data are reliable. Another important lesson comes from the lack of measurement of real time dweller engagement with the ICT solutions (only available at the end of the monitoring period), which could have been used to understand clearly long term engagement, training session impact or user interface usability at virtually no cost.

- ***Mix use of bills and measurements:*** The use of both bills for long term assessment and measurements for analysing the details week per week and day per day into the dwelling gave a good balance of information and allowed to ensure the data quality through cross comparison. However, it is often difficult to collect the bills from tenants and even sometimes from building owners if they are not directly involved in the project.

- ***Data assessment and interpretation:***

- ICT systems' impacts are concentrated on "small" behavioural changes (on temperature demand, on electricity consumption, and also in some way in comfort management). It is especially difficult to detect these subtle evolutions of behaviours.

- The development of a dedicated interface for building managers eases the analysis tasks as it provides more advanced features for data treatment, such as the parallel comparison of different measurements.

- Savings were evaluated in E3SoHo on the basis of a comparison of different periods. In first place, a comparison was done between the total consumption of the sample of dwellings in the pre-monitoring and in the monitoring periods. An additional calculation was realized as a mean of the individual evolution of consumptions of each dwelling between the two periods. Additional analysis have been done for identification of larger savers, larger consumers, and correlation between savers and consumers, as well as the potential of savings based on results obtained by tenants who have saved energy.

- ***Stability of consumption patterns:*** It appeared during the project that the results were highly sensitive to two aspects: Dwelling individual behaviour (highly variable from one dwelling to another), and month to month evolution, which is also very important in some cases without clear explanations. It would be advisable to extend pre-monitoring and/or monitoring periods over more than one year (at least with energy bills).

- ***Adjustment techniques:*** Independent parameters such as outside temperature were integrated in the calculation of heating consumption to adjust the results to the context of the monitoring period (Heating Degree Days). However this approach revealed to be rather weak to tackle completely the issue of seasonal variation of the results as the heating results were still following an irregular curve among the year.

- ***Practical implementation issues:*** Communication and batteries are among the main issues with actual technologies. Compatibility with existing counters, existing meters or existing communication systems can also be tricky. The capacity of the monitoring system to detect errors and to evaluate the accuracy of the treated data (i.e. missing data or data indicating a wrong value) is an important issue as it impacts both uses of the data collected: for information display to the tenants and for the project monitoring purpose.

- ***Stakeholders involved:***

- The ICT system was used to evaluate and monitor the results of an ICT based technology. This situation represents a high risk of confusion, especially for non-expert stakeholders, mainly the tenants. It is therefore difficult to assess if the first step of the implementation (pre-monitoring) did not influence already behavioural changes for tenants.

- Local technical representation is an important plus to control implementation quality

- A regular communication process between stakeholders is needed for such project, and the communication with tenants was ensured in E3SoHo by partners responsible of each local site. However it may be a good opportunity in further projects and commercial systems to get automatically feedbacks from the tenants via the ICT display itself.

8 Target groups

The results of the E3SoHo project can be relevant for the following target groups:

- **Public and Private Social housing building providers (owners/managers):** following the same approach used in the project, one of the most efficient ways of reaching a high number of end users is to offer the E3SoHo solution to public or private organizations which own and/or manage social housing dwellings for rental, which can decide to undertake large scale deployments of ICT solutions for energy efficiency in their housing stock and would then offer the service to their tenants. In the case of social housing for sale, providers could integrate the service as an added value for the dwellings in new buildings.

- **Social housing tenants:** social housing tenants can be addressed directly offering them the direct purchase of the ICT solution for their homes, mainly through online sales channels.

- **Social housing owners:** it shall be considered that in some countries (e.g. Spain) part of the social housing stock is provided in the form of low-cost housing for sale, with limits both in terms of the income of beneficiaries and the price and size of the accommodation. Owners of this kind of dwellings can be targeted in a similar way to owners of dwellings from the open residential market, mainly through online sales channels.

- **Private owners under a community of owners framework**: the E3SoHo solution could be offered to communities of owners in order to install it in common areas and within all the dwellings whose owners want to use the service and pay for it.

- **Facility managers and building maintenance companies, ESCOs:** Companies in charge of the management of facilities of different types (residential, commercial or public buildings) are increasingly assuming the role of implementing action plans for the improvement of energy efficiency in these facilities. This responsibility will normally be reflected in the facility management contracts through specific clauses related to this topic. Therefore, facility management and building management companies as well as ESCOs is another target group for the E3SoHo solution.

- **ICT solutions & BEMs and metering providers:** ICT-based solution providers could enter in the business of BEMS by providing the E3SoHo solution, either directly to building owners, to construction companies, to facility managers or through other BEMS/BAS providers. The E3SoHo solution can also be integrated with smart metering systems which are currently being massively deployed throughout Europe.

- **Energy Efficient Building construction & refurbishment companies, energy consulting companies, architects and engineering companies:** these stakeholders can foster the integration of the E3SoHo solution either in new real estate developments, or in building retrofitting projects. This could be done in partnership with specialized SMEs providing installation, maintenance and consultancy services for the operation of the solution.

- **Utilities:** utilities shall be addressed as they can offer the E3SoHo solution as an added value service to their customers, which will run on top of the smart metering deployments which are currently in process.

- **Smart Cities, Smart City community:** municipalities involved in smart cities developments, and the communities formed around these, shall be addressed in order to promote large scale uptake and replication of the E3SoHo solution as a means of achieving significant energy savings at city level.

- **Policy makers at European, National and Regional level:** the E3SoHo solution, together with other similar solutions developed in other European projects or already available in the market, is one of the enablers to be considered by policy makers in order to achieve the objectives of the 2020 strategy.

9 Dissemination

Conferences

Participation in conferences has been one of the main channels used by E3SoHo partners to disseminate the project objectives, progress and outcomes. Partners have participated in a total of 69 conferences, of which the most relevant ones are listed in the table below.

Date	Venue	Title	Date	Venue	Title
08.Dec.2010	Warsaw	Smart metering	11.Jan.2011	Zaragoza	Social housing
21.Feb. 2011	Warsaw	Television interview	31.Feb.2011	Zaragoza:	Master on E. E
28.Apr. 2011	Warsaw	Awareness Campaign "Meet & Cooperate"	12.May.2011	Madrid,	AVS conf. on social housing
31.May. 2011	Barcelona	ACCA. Zaragoza Experience	01.Jul.2011	Anglet,(Fr))	Nobatek partner's day
05.Jul.2011	Toulouse,	ENHR Conference	08.Jul.2011	Talence,(Fr	Rencontres du pôle CREAH
13.Sep.2011	Warsaw	Innovative energy buildings in the cities	05.Oct.2011	Warsaw.	ECTP-E2BA Eracobuild conference
06.Oct.2011	Venice	Centro Congressi San Servolo	12.Oct.2011	Paris	Journées de la performance énergétique
24.Oct.2011	Nice	ICT4 Sustainable homes,	28.Nov.2011	Warsaw	Awareness Campaign "Meet & Cooperate
17- 20.Nov.2011	Warsaw	University of Technology. Seminar	24.Nov.2011	Cagnes sur mer,(Fr)	INDUSTRIA 2011,
29.Nov.2011	Warsaw	Sustainable construction Workshop	09.Dec.2011	Warsaw	Smart Cities. Cities practice on action
15.Dec.2011	Warsaw	University seminar on "Intelligent Building Systems"	01.Feb.2012	Warsaw	Scientific seminar IUSER
02.Feb.2012	Angers (Fr)	French national workshop. "ICT for Sustainable	09.Feb.2012	Warsaw	Meeting towards smart cities with

Date	Venue	Title	Date	Venue	Title
		housing"			NEDO
30.Mar.2012	Sofia	2nd EU Workshop on ICT4E2B	10.May.2012	Kielce (Pl)	ICT, green technologies and EE workshop
10.May.2012	Warsaw	InnoZ. Intelligent City Workshop	25.Jul.2012	Reykjavik Iceland	ECPPM 2012 Conference,
27.Jul.2012	Paris	Intelligent Building Systems Conference	04.Oct.2012	Kraków	Low carbon trend-setters workshop
02-03.Feb.2012	Angers	French National workshop: "ICT and Social Housing:	30.Mar.2012	Sofia	Harmonization projects in "ICT for E.E Buildings"
17-18.Apr. 2012	Warsaw	Clean Energy and Sustainable Buildings – CEP Poland	16-18.May.2012	Boston MA, USA	2012 IEEE International Symposium on Sustainable Systems and Technology
25-27.Jul. 2012	Reykjavik	ECPPM2012 - European Conference	06-07.Sep. 2012	Lisbon,	1st Int'l Workshop (IT4ENERGY'2012)
14-16.Sept.2012	Ponta Delgada - Azores, PT	International Workshop on Energy Efficiency for a More Sustainable World.	13.Nov.2012	Barcelona	Smart City Expo World congress "ICT for energy management in building:
10.Apr.2013	Paris	Delphi. Workshop for sharing lessons learnt ICT for EE in social housing	24.Apr.2013	Genova	Post degree course for architects and engineers -
06-08.May.2013	Madrid	GENERA 2013 – Energy and Environment International Trade Fair	22-23.May.2013	Sant Cugat del Vallès (ES)	3eHouses congress
18-19.Jun.2013	Nice	Innovative City Convention 2013	18.Jun.2013	Oporto, Portugal	CiWork 2013 – CISTER –Real

Date	Venue	Title	Date	Venue	Title
					Time Embeded Computing System

Publications

E3SoHo project partners have produced a set of publications addressing different dissemination channels. These include mass media (e.g. newspaper, TV news), specialized magazines, internal corporate newsletters, and scientific conferences.

Date	Where	Publication Title
February 2011	Rzeczpospolita (Poland)	Article in Rzeczpospolita (Daily newspaper in Poland) - Dom oszczędny w Ursusie
February 2011	Superstacja TV (Poland)	Video about the E3SoHo project
February 2011	TVN Warszawa - Witai Warszawo	Video and interviews on the E3SoHo project
May 2011	Aquitaine Region newsletter	Article dedicated to EU projects
December 2011	European Energy Innovation Magazine	E3SoHo – Energy Efficiency in European social housing
December 2011	DAPP Newsletter	D'Appolonia meets the Genoa Mayor, Ms. Marta Vincenzi, during the installation of Energy Efficiency ICT solutions for the FP7 European Project E3SoHo - – San Pietro Quarter, Genoa
March 2012	Workshop summary published on BUILD UP web portal	eSESH, BECA and e3SoHo Workshop's report (French National workshop in Angers) http://www.buildup.eu/news/25195
July 2012	Reykjavik, Iceland	Energy Efficiency in European Social Housing – Three pilots across Europe demonstrating the enabling factor of ICTs to sustainable growth

National & International workshops

Another powerful dissemination tool used by E3SoHo has been workshops. Four National workshops have been organized during the project - some of them in cooperation with other FP7 and sister ICT PSP projects - in France, Italy, Poland and Spain. Besides, one European workshop has been organized in Brussels

National workshops were excellent opportunities to increase awareness of the project in the countries where the pilot sites were located. They offered opportunities to hold discussions

related to E3SoHo solution performance and applicable business models, taking into account National specific contexts: National building and energy regulations, National incentives for energy refurbishment and/or related to social housing, etc.

The table below provides the basic information of all the National and European workshops which have been either organized by E3SoHo or co-organized with other FP7 and sister ICT PSP projects. These does not include other workshops where E3SoHo has participated, and which have been already been counted as conferences.

Workshop	Date	Place	Number of attendees
France	02-03 February 2012	Angers	65
Italy	18-22 March 2013	Genova	50
Poland	26 March 2013	Warsaw	71
Spain	25 September 2013	Zaragoza	80
Belgium	18 September 2013	Brussels	50

E3SoHo Project website and electronic newsletters

The E3SoHo project public website has been one of the main instruments used for dissemination, almost since the project start, until its finalization. Besides, it will be kept active at least during five years after the end of the project, in order to use it as a support tool for future dissemination and exploitation.

As a dissemination tool, the public website will maintain all the materials which have already been made available, such as the general description of the project, information about the pilot sites and the project partners, project flyers, press articles and videos, and a collection of past relevant events and of the electronic newsletters which have been published periodically by the consortium. The table below compiles the front pages of all the published newsletters, including a list of the main topics addressed in each of them.

No. 01. Oct.2010	**No. 2. Jun.2011**	**No. 3. Sep.2011**
• Editorial • Pilot in Warsaw • Pilot in Lievin • Pilot in Zaragoza • Survey on tenants • Project information • Past events & Upcoming events	• Preface • News about pilots, especially the introduction of a new pilot: Genova, Italy • Description of an ICT available solution: ISA solution.	• News about pilots: - Genova, Italy - Warsaw, Poland

		
No. 4. Nov.2011 • Zaragoza pilot in Spain, • Next French National Workshop, • D6.1 (Methodology for design) submission.	**No. 5. Mar.2012** • Workshop in Angers • Pre-pilot deployment report • Pilot deployment report • Workshop in Sofia	**No. 6. Jun.2012** • eeMeasure workshop in Brussels • CECODHAS event in Brussels • Methodology for monitoring • Polish software user interface
		
No. 7. Oct.2012 • Smart City Expo in Barcelona • Users acceptance initial report • ICT system performance initial report	**No. 8. Feb.2013** • Socio-economic & marketing report • Report from the UK National Housing Federation: “Approaches to engaging households with	**No. 9. Aug. 2013** • E3SoHo final event, Brussels, 18th Sept. 2013 • ”Watt & moi” pilot project, led by ERDF • Report on the 3eHouses congress (May 2013,

	their energy use”	Barcelona) • Report on the Genova Spring Exhibition - “Smart building in a smart city” (March 2013, Genova)
		

As an exploitation tool, the E3SoHo website will provide, on one hand, all the project public deliverables, which will make accessible to external stakeholders most of the conclusions and lessons learnt in the project, and can be therefore used as reference material for future replication.

The table below provides, in chronological order of publication, a list of all the public deliverables which will be available for download once that they are definitely approved by the European Commission. This table includes also a brief description of the contents of each deliverable.

On the other hand, the E3SoHo website will be used as the main contact channel for any external stakeholder who would like to retrieve additional information from the consortium, or is seeking guidance or establishment of partnerships for replicating the project results in other buildings. Enquiries received through the project public website will be managed and answered directly by the project coordinator, or forwarded to specific project partners, if needed. A contact from ISA will also be provided in the public website for any enquiry related to the technical E3SoHo ICT solution. Other partners will also take the responsibility of managing enquiries from specific countries, for instance Nobatek will manage contacts from French organizations, while D’Appolonia will do something similar in the case of Italy.

E3SoHo Public Deliverables	
Deliverable number	**Contents**
D7.2.1 Initial dissemination	Presentation of the overall initial approach proposed in order to

E3SoHo Public Deliverables	
Deliverable number	**Contents**
and awareness plan	disseminate and advertise the set of results of the project.
D2.3 Best technical and cost-effective ICTs	Description of the different ICT technologies and integration techniques identified for fulfilling the set of requirements obtained in Task 2.1 (User Requirements) and Task 2.2 (Building Requirements). This analysis therefore documents, among others, the technologies utilized in E3SoHo, and provides references such that the selection process could be replicated in order to develop a generic ICT solution for social housing across Europe.
D7.2.2 Initial dissemination and awareness plan #1	Preliminary view of the anticipated public results, report on dissemination instruments activated during the first year of the project (e.g. flyer, e-Newsletter, etc.) as well as the main dissemination activities accomplished.
D6.1 Methodology for design	The design methodology represents the overall approach used to develop and implement energy efficiency services for social housing (dwelling, flat, or building) around the following issues: Non-technical aspects; application of IPMVP; technical aspects; pilot activities.
D4.1 Pre-pilot deployment energy consumption report	This report establishes the baseline of “normal” consumption and energy use pattern in the pilots before the installation and launch of energy efficiency techniques in the apartments. It presents first the procedure followed for the measurements and the results obtained for the pre-monitoring in each pilot
D6.2 Methodology for implementation	Guidance for stakeholders through the planning and execution steps of the installation activities associated with ICT energy efficiency solutions for social housing. One special area of focus in this deliverable is Awareness & Training. A second area of focus in this report is the installation activities at the three project pilot locations: successes, challenges, lessons learned, awareness and training activities, and costs.
D.7.2.3 Initial dissemination and awareness plan #2	List of dissemination activities captured during the second year of the project, update of some dissemination efficiency indicators, and overview of forthcoming dissemination activities until the end of the project.
D.6.3 Methodology for monitoring	The monitoring methodology reports the approach used in order to monitor the energy consumption after the installation of the

E3SoHo Public Deliverables	
Deliverable number	**Contents**
	ICT-based solutions. It provides the details for the definition of measurement and verification plan in order to be able to estimate the real achievement coming from the ICT implementation.
D4.3 Deployment of the awareness and training plan at pilots' level	Recollection of the awareness and training activities performed in each of the three pilot sites of the E3SoHo project in order to teach and inform tenants on the ICT solution deployed in their dwellings for achieving energy savings in social housing, including an annex with all the documents delivered to tenants within each pilot.
D5.1.1 ICT System's performance initial report	Initial performance report after the two first months of monitoring, including evaluation of the first impact of the ICT solution, evaluation of the summer period results, and feeding with experience the ICT system design improvement process. This report was extended later including evaluation of the first ten months of the monitoring period.
D5.2.1 User's acceptance initial report	Initial evaluation report addressing the acceptability of the ICT solution by users, and the efficiency of the solution. The report also includes an extensive definition of who the users of the E3SoHo solution are.
D5.1.2 ICT system's performance final report	Conclusions and lessons learnt containing a final overview of the results in energy consumption and energy use patterns as measured in the three sites of implementation of the E3soHo solution.
D5.2.2 User's acceptance final report	Final evaluation report addressing, through different methodological tools (e.g. questionnaires) the acceptability of the ICT solution by users, and the efficiency of the solution, analysing the final feedback obtained from users as tenants and from users as building managers.
D.5.3 Validation report	Comprehensive assessment of the ICT solution developed, installed, and refined during the duration of the project. A goal-based evaluation has been carried out on the following topics: Solution assessment, energy savings, engagement of the users, economic benefits and social impact.
D.6.4 Global methodology	Description of the overall methodology, from design to monitoring through implementation, developed within E3SoHo

E3SoHo Public Deliverables	
Deliverable number	**Contents**
	project. The deliverable resumes the contents of previous deliverables D6.1, D6.2 and D6.3, and integrates them with the lessons learnt on the field, during the implementation phase, the monitoring and the maintenance.
D.7.2.4 Final plan for the dissemination of project results	List of dissemination activities captured during the third and fourth years of the project. Final update of dissemination efficiency indicators. Overview of the final E3SoHo European workshop, and annex with a summary of the National workshops.

10 List of all beneficiaries with the corresponding contact name and associated coordinates

Company	**Contact name**	**Contact email address**
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Company	Contact name	Contact email address
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Comune di Genova	Virgilio Bessaza	virgiliobessaza@comune.genova.it

11 The address of the public website of the Project as well as relevant contact details.

www.e3soho.eu

Régis Decorme (regis.decorme@cstb.fr): Dissemination coordinator

Javier Mardaras(jmardara@acciona.es): Project coordinator