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COST OPTIMUM AND STANDARD SOLUTIONS FOR MAINTENANCE AND MANAGEMENT OF THE SOCIAL HOUSING STOCK

REPORT ON THE INNOVATIVE MEASURES: "FACTSHEETS"

Co-funded by the Intelligent Energy Europe Programme of the European Union

INVENTORY

SUMMARY

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INVENTORY

INTRODUCTION & REMINDER

The Inventory is the first step in the AFTER project.

This deliverable aims at **collecting innovative measures and practices concerning energy savings implemented in the European Social Housing Stock** during the last 5 years before November 2011. This document aims at providing :

- a **toolbox of standardized practices concerning the energy efficiency of the existing social housing stock** (including a corresponding technical feedback concerning their qualitative implementation).

- a **simple database synthetizing key pieces of information and figures about past experiences regarding energy saving measures** in the participating Social Housing Companies (cost of investment, scale of implementation, measured percentage of energy savings).

This document is depending on to the existing feedback of the social housing practionners concerning energy saving measures.
Its objective is to include a good panorama of practices identified as relevant for the energy efficiency of the existing stock. 18 of these measures will be exhaustively monitored and optimized during the forthcoming phases of the project in order to guarantee their efficency and reproductibility at a larger scale.

As a first step of this approach, the AFTER Inventory answers to the following questions :

- What are the most innovative/recurring energy saving measures concerning the maintenance and management of the social housing stock that have been implemented during the last 5 years ?

- What are the attentions points and recomandations to guarantee the good implementation of these measures ?

- What are the existing feedbacks of the AFTER partners about the implementation of the measures (quantitatively and qualitatively) ?

This introduction presents the main definitions and the structure for this deliverable.

I. DEFINITION : ENERGY SAVING MEASURES

II.1. SELECTION CRITERIAS

AFTER Inventory gathers a large range of Energy Saving Measures (ESMs) concerning **the management and the maintenance of the buildings** and corresponding to the following **criterias** :

1. The measure has **been implemented in order to improve the energy consumption, the energy costs, and/or the thermal comfort** of a building/a group of buildings.

2. The measure is **concerning heating aspects, warm water production or electric powering of a building and its systems**. As heating represents the main part of the energy consumptions, measures concerning heating will be highly expected.

3. The impacts of the measure can be **monitored and evaluated in a first time regarding its investment costs and immediate savings in terms of energy**.

4. The measure has **a potential to be improved regarding its economic/energy/social performance**. Its efficiency on the short-term can still be optimized thanks to small technical or behavioral adjustments after its implementation.

5. The measure has been implemented within the last 5 years before November 2011. At least **one year of baseline before the implentation and one year of reporting after** are available to identify the percentage of savings realized thanks to the measure.

I.2. MAIN ORIENTATIONS

The AFTER project focuses on the wider potential for energy savings in the social housing stock. As mentioned in the project objectives, the intention is not to focus on minor cases or complex innovations. **The AFTER projet is about 100% of the social housing** and will try to identify how energy can be saved at a larger scale of the European social housing stock.
As a consequence, the project will mainly be interested in the most common typologies of buildings and systems for the Social Housing Organizations in Europe.

This approach is not limitative but will orientate the Inventory regarding representative topics and features such as:

- **collective buildings** implemented in **urban context**.
- buildings with **central heating systems** (85% of the European dwellings in 2009) and a majority of ESMs concerning space heating in order to target the main energy consumptions (68% of the consumptions in the existing stock of 2009 as presented in the diagram below)[1].
- Buildings using **natural gas** as main energy carrier.

	Dwellings with centralised water heating and heating systems in the participating SHO (at the building or the district level)
France	3 400
Germany	7 800
Czech Republic	7 641
Italy	700
Slovenia	25 000
Denmark	3500
TOTAL	48.041

Fig.1: Estimated number of dwellings potentially concerned by the evaluation phase of the project in the participating SHO

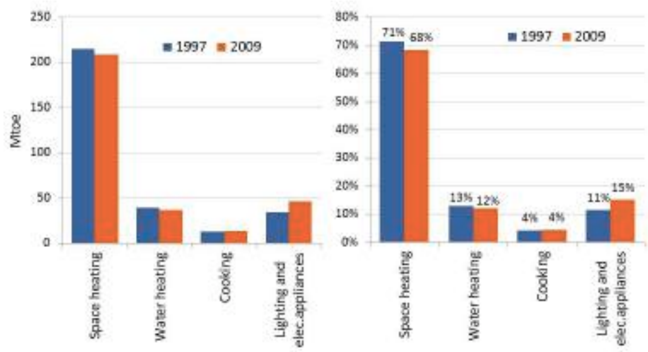

Fig.2: Breakdown of household energy consumption by end-use (EU). Source ODYSSEE

II. GENERAL ARCHITECURE OF THE INVENTORY

1 Energy Efficiency Trends in Buildings in the EU , Lessons from the ODYSSEE MURE project, Intelligent Energy Europe, September 2012

« *Space heating represented 68% of total household consumption in 2009 compared to 74% in 1990. The share of electricity for lighting and appliances increased from 10% to 15% in 2009 compared to 1990. Water heating remains stable at 12% in 2009 (Figure 3). Most of the savings in energy consumption in the household sector took place because of improvements in space heating technologies and tighter building codes.* »

II.1. TYPOLOGIES GRID

The Inventory is divided in 5 segments corresponding to the 5 topics included in the genral management and maintenance of the housing stock. These main categories will allow us to tackle several types of Energy Saving Measures : technical/not technical, long-term/short-term, etc.

These **5 work packages correspond to the following items as detailled in the « Typologies » report included in the AFTER Scientific Methodology**.
As a summary, its is possible to synthetize the 5 work packages as follows :

- **« Operative management »** gathers ESMs concerning the organizational and human aspects of the energy saving strategies (energy contracts, tenants awareness, professional training).
- **« Running Maintenance »** gathers ESMs concerning punctual, low-investment, and potentially renewable interventions/adjustment on the structure of the building and/or its system.
- **« Replacement of systems »** gathers ESMs concerning most important investment regarding the exchange of old heating, warm water production or ventilation systems and for newest most efficient ones.
- **« Recently Refurbished Buildings »** gathers ESMs and examples of retrofitting of buildings, from the global renovation of the building to singular renovations of the most important parts of its structure (facades, roof, etc.).
- **« Recent Low-Energy-Buildings »** gathers buildings corresponding to high performance energy objectives. These buildings often combine several types of ESMs highly interdepend between each other.

This variety will allow us to **cover a large panel of interventions aiming at the improvement of the energy performance**.
The main ambition of the AFTER project is to propose solutions both connected to **the « hardware » aspects of the building** (interventions on the systems, the structure) and **« software » solutions** (awareness, quality processes).

II. 2. DISTRIBUTION OF THE FACTSHEETS

For every one of the 4 first work packages, an amount of 24 Energy Saving Measures will be identified and inventoried.
Concerning the Work Package dedicated to « Low Energy Building », the SHOs have less examples in their housing stock.
As a solution, WP7 stakeholders have decided to mainly focused on 4 well-documented feedback concerning low-energy buildings. These 4 buildings will be detailled and assessed regarding the specificities of their systems and a special chapter will be dedicated to every main type of system (insulation, ventilation, windows, supply system).

In addition to the existing framework of work packages, the energy saving measures inventoried have been selected regarding several relevance factors. These factors include :

- **The representativeness of the measure in the social**

housing practices concerning energy managament. The objective is to identify some recurrent actions implemented by the SHOs and improve the knowledge about them (using, for example, a comparative approach).
- **The potential for innovation of the measure**. The objective is to identify new practices or practices having a lack of feedback.
- **The opportunity to adapt the measure in several national contexts**. The objective of reproducibility is part of the AFTER project. The measure has to cover representative topics or typologies of buildings.
- The **complexity of the thematic scope attached to the measure**. Inventoried measures are not only targeting energy savings concerning heating. The potential of the measure will have also to tackle social aspects of the energy management (tenants behaviors for example) and to include a reflexion concerning renewable energies is increasing its relevance.

These factors are, of course, non-excluding fields and can be perfectly complementary.
These indicators and quality baselines will help us to focus on the most significant energy saving measures. It also helps us to identify the potential for a measure to be adapted, developed and optimized in the forthcoming phases of the AFTER project.

The AFTER Inventory will lead to the pre-selection of the 18 Pilot ESMs selected to be tested on Pilot Sites. Among the 84 measures inventoried, Social Housing Organizations and Scientific partners will select relevant cases to be discussed and deepend thanks to an experimental approach.
The selected Pilot ESMs will have to respect several of the relevance factors of the Inventory and to present special opportunities to be widespread at a larger scale of the European Social Housing Stock.

As a result, the Inventory has to be read and understood as a preparatory document that will lead to this selection process. The deliverable is both a catalogue of innovation and documented best practices and a first identification tool that will be use as a basis for experimental testing.

III. GOING THROUGH THE INVENTORY

The AFTER Inventory provides **a general and pragmatic overview for a large selection of Energy Saving Measures**.
This overview is gathering the scientific analysis and contributions of the participating research institutes and the professional feedback of the social housing technicians.
The main objective is to sum up outputs of the scientific letterature concerning the measure and to complete them with some practical pieces of information provided by the SHOs that already have some existing feedback about the operational implementation for these measures.
This experience will be enhanced by some examples of testing and the corresponding figures.

The Inventory follows the same template for every work package of the project. The structure is the same and will be repeated for every measure in order to make easier the general readability of the document.

III.1. USING THE AFTER SCIENTIFIC MAP AS GUIDE

The Inventory has been completed by the AFTER partners using the scientific deliverables prepared during the first months of the project.
The two main elements of the Scientific methodology that will be used through the Inventory are :

III.1.A. Typology list

The typology list provides a detailled assessment of the content for every single work package.
This part of the scientific deliverable will help to identify what are the types of Energy Saving Measures included in every work package. This deliverable provides a framework to classify and to individualize the different types of interventions that can be implemented regarding the management and maintenance in every work package. It delineates the main families of interventions and intentions that will be included in our catalogue of inoovations.

III.1.B. Handbook

The Handbook contributes to present a framework of indicators helpful to assess the inventoried energy measures. This part of the scientific deliverable is guaranteing to have a global coherence on the data collected by the partners of the project.

Every information provided by the participating partners will be repertoried regarding the conditions highlighted in the Handbook.

III.2. STRUCTURE OF THE INVENTORY

Within every work package the description for a type of intervention is divided into two parts :

- a **general description of the type of energy saving measure** listed by the partners.
- **feedbacks on concrete examples** for these types of measures implemented within the last 5 years by the AFTER participating SHOs : **the socalled « Factsheets ».**

The different types of energy saving measures may be completed and illustrated by one or several Factsheets (presenting concrete study cases). Some Factsheets are repetitive as they are linked with the same type of intervention or investment. They will feed the measure inventoried with various feedback (from one or several housing companies). These complementary examples will deliver a better overview on different scenarios for a same type of action.

III.2.A. General description of the Energy Saving Measure

The first part of every chapter will introduce the Energy Saving

Measure thanks to simple description features.
The objective is to obtain an immediate identikit of the measure covering its technical aspects, its objective and some pieces of information concerning the routines in the Social Housing Organizations impacted by this particular measure.

The categories for every measure are highlighted below.

III.2.A.a. Introduction

The introduction offers a simple presentation of the measure.

The two main pieces of information provided concerns :

- the **integration of the measure in the typology of the AFTER project**.
- a **simple explanation of the main stakes and issues related to the Energy Saving Measure** (What is the part of the building involved / What are the mains objectives of the measure / What is its development context according to the issues of the social housing sector).

III.2.A.b. General ESM Technical Description

This part provides a simple presentation of the measure.
Its objective is to provide in one page **a general understanding of the implementation of the measure and its consequences for the Social Housing Organizations in terms of management, maintenance and tenants eco-empowerment**.

This part is presenting :

- **technical aspects for the ESM** : with a description of the operating principle for the energy saving measure, the technical characteristics linked with its implementation and action.
- **maintenance aspects for the ESM** : with a description of the tasks detailed in the ISO 15686-5[1] : "*Total of necessarily incurred labour, material and other related actions incurred to retain a building or its parts in a state in which it can perform its required functions (maintenance includes conducting corrective, responsive and preventive maintenance on constructed assets, or their parts, and includes all associated management, cleaning, servicing, repairing and replacing of parts where needed to allow the constructed asset to be used for its intended purposes)*"
- **operating aspects for the ESM :** with a description of the tasks detailed in the ISO 15686-5 : "*Costs incurred in running and managing the facility or built environment, including administration support services (Operation costs include rent, rates, insurances, energy and other environmental/regulatory inspection costs, local taxes and charges)*"
- **tenants awareness aspects for the ESM :** the tenants awareness actions aims at reaching a good efficiency for a measure involving its users.
- The **gap between the technical expectations and the behaviors of final users can lead to major issues in terms of savings**. The Tenants' awareness aspects focus on the actions and conditions aiming at modifying the behaviors and reception of the tenants regarding to energy specifications and technical innovations in order to reach their expected performance. This approach is involving a reflexion both on the general level of information[2] provided to the stakeholders and a more ergonomic conception of the technical innovations including a behavorial approach[3].

1 ISO 15686-5 Buildings and constructed assets - Service life planning: Part 5, Life-cycle costing.

These operating, maintenance and eco-empowerment aspects will be included during the complete life-cycle of the Energy Saving Measure.
The diagram included in Figure 3 presents some possibilities to identify these aspects at 6 main moments of an ESM life-cycle.

III.2.A.c. Tips and attention points

The **tips and attention points aim at enhancing the knowledge about the Energy Saving Measure using the professional feedback of the practionners**.
Technical descriptions provided thanks to the scientific litterature will be completed with some technical recommandations coming from the operative staff of the participating Social Housing Organizations.

This on-field experience is necessary to better understand what are the pragmatic conditions to reach the expected performance for an intervention targeting energy savings. Tips and attention points partly correspond with the concept of « *Pre-functional/Construction checklist* »as described in the litterature concerning retro-commissioning process (for a larger overview on the commissioning topic please refer to the part dedicated to the topic in the AFTER Scientific Methodology).
The Pre-functonal/Construction checklist is defined, in the commissioning litterature, as *« a checklist to ensure that the specified equipment has been provided, properly installed, and initially started and checked out adequately in preparation for full operation and functional testing (e.g., belt tension adjusted, fluids*

2 Bartiaux, Françoise (2008): Changing energy-related practices and behaviours in the residential sector: Sociological approaches.
Paper presented at the Efonet workshop "Behavioural changes – backcasting and future trends". Madrid, 6./7. November 2008.

"*Environmental and social psychologists have tested the effects on energy conservation of most of these variables of attitudes and values in numerous studies. A remarkable synthesis of their work is done by Abrahamse, Steg, Vlek and Rothengatter (2005). In brief, the following intervention types have been successful: commitment to save energy (based on the so-called foot-in-the-door technique), goal setting and especially so if combined with feedback, frequent or comparative feedback, information if combined with other interventions whereas mass media campaigns, tailored energy advice and modeling (providing examples of recommended behaviours in booklets for example) lead to inconsistent results on energy savings. Combined interventions appear thus to give better results. Social scientists have further studied the conditions for information being effective in changing energy practices*".

3 Heijs, Wim (2007): Residential energy use: habitual behavior and possible interventions. In: Conference Proceedings "First European Conference Energy Efficiency and Behaviour", 18.10.2009, Maastricht.

« The following step consists of a try-out of the strategies on habit(ual behavior) with a large energy-saving potential, and the implementation of the necessary changes. (...) With a view to the prevention of undesirable habitual behavior, an extrapolation from the results of intervention studies can provide insight into the possibilities for precluding the generalization of unwanted activities. It is advisable to investigate the options for the formulation of explicit conditions regarding the design of new products to prevent unwanted habits and to enhance the coherence with 'natural' behavior, analogous to existing ergonomic and safety regulations".

topped, labels affixed, gauges in place, sensors calibrated, voltage balanced, rotation corrected)"[1] .

The **AFTER Inventory provides a synthetic version of this type of list with some recommandations to guarantee the performance for the identified Energy Saving Measures**.
The EPA Building Commisioning Guidelines mainly focus on the technical conditions to test before, during and after the implementation of an ESM. The AFTER project will complete this approach with additional attention points concerning non-technical recommandations.
The technical aspects are requested to ensure the performance for an ESM. But **they have to be completed by a complementary approach of the behavioral aspects** (tenants, staff of the Social Housing Organization).

This particular attention is part of the AFTER specifities. The project presents **a systemic and general integration for an energy saving measure**.
The energy saving measure is not only described regarding its own specificities. It is also **detailed regarding its interdependency with other systems and equipment of the building and the potential corresponding risks**. The interdependency with the tenants and practionners actions and behaviors is also fully integrated within a « macro » approach. This complexity of the system is a general attention point to improve concerning the understanding of the energy potential for a measure. This ambition matches with the conclusions of several European projects dedicated to energy, as mentioned for example in the report « Retrofits insights : perspectives for an emergy industry »[2] produced by the Institute for Sustainability : *« While dwellings and their energy systems are physical systems, they are not independent of social and organisational behaviour. The interactions between the different components (heating and ventilation systems, solar thermal etc) and the physical envelope of the dwelling, and with the people who retrofit and inhabit it, form a complex system whose behaviours cannot always be predicted, particularly during times of rapid change».*

The potential for a qualitative pedagogical transition regarding the new measures implemented has also to be considered as a critical success factor[3].
As a consequence, **the description of the Energy Saving Measures will be connected with « tips » concerning potential awareness actions and incentives to guarantee their good integration by the final users**.

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1 EPA building commissioning guidelines (2009), Environmental Protection Agency Facilities Management & Services Division, Washington, January 2009.

2 Low Carbon Domestic Retrofit. Retrofit insights: perspectives for an emerging industry. Key findings: analysis of a selection of Retrofit for Future projects. Institute for Sustainability, London, 2012.

3 Dietz Thomas, Gardner Gerald, Gilligan Jonathan, Stern Paul, Vandenbergh Michael, Household actions can provide a behavioral wedge to rapidly reduce U.S. carbon emissions, Indiana University, Bloomington, 2009

« *The most effective interventions typically (i) combine several policy tools (e.g., information, persuasive appeals, and incentives) to address multiple barriers to behavior change; (ii) use strong social marketing, often featuring a combination of mass media appeals and participatory, community-based approaches that rely on social networks and can alter community social norms; and (iii) address multiple targets (e.g., individuals, communities, and businesses) (12, 14, 23, 26).(....)interventions that combine appeals, information, financial incentives, informal social influences, and efforts to reduce the transaction costs of taking the desired actions have demonstrated synergistic effects beyond the additive effects of single policy tools (12, 13, 28). "The most effective package of interventions and the strongest demonstrated effects vary with the category of action targeted."*

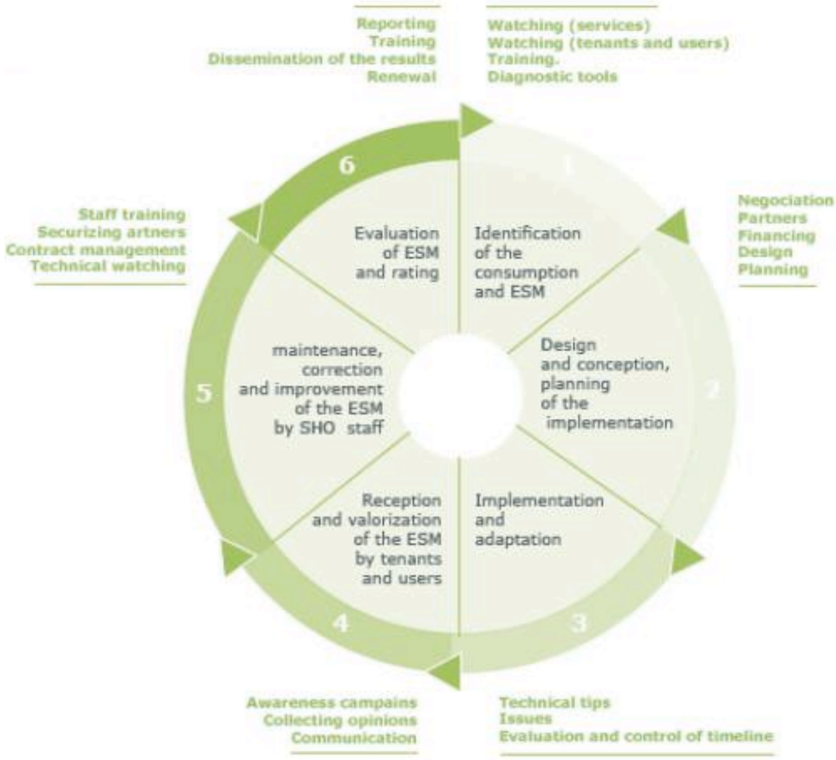

Figure 3 : Diagramm presenting the several moments constituting the operating management and running maintenance for an energy saving measures in a building/or a group of buildings. This scheme illustrates 6 main phases from the decision-making process to the evaluation of the ESM including its implementation. These phases contains opportunities to improve the efficiency for an energy saving measure within an organization and highlight what types of main actions can be identified as maintenance or operating aspects connected to a special energy investment.

III.2.B. Factsheets

Factsheets are providing examples of implementation in a large part of the Social Housing Stock.
The participating partners of the project have inventoried several experiments for every measure listed. Factsheets will offer a detailed overview on on-sites implementation. They will highlight several technical aspects concerning a measure and potential scenarios.
For every measure, the AFTER proposes concrete examples for these identified ESMs implemented on concrete buildings and with figures.
Every Factsheet will follow the same structure :

- **description of the building**.
- **description of the ESMs implemented with technical details** (when available).
- **data basis with the relevant figures to assess the ESM** (including costs for investment, energy consumptions and potential other indicators).

The indicators used for every category are defined in the Handbook of the AFTER project.

III.2.B.a. Description of the building

As mentioned in the Scientific Methodology of the project, buildings involved in the AFTER project are described according to simple typology.
The main intention is to identify quickly **the main details regarding the shape of the building, its height, surface and year of construction**. All these details will allow to identify the type of the building and its potential energy uses (the energy carrier is also mentioned).
The complete address of the building is also provided in order to potentially localize the building on GoogleMaps© or GoogleStreetView©.

The building typology has been completed using existing material from other European project. The methodology developed in the project TABULA IEE/08/495 (Typology Approach for Building Stock Energy Assessment)[1] has been used in order to highlight and define the main relevant cataegories.

The aims is to focus on the most important information to identify a building :

- **Adressing and ownership:**
  Including the Social Housing Organization managing the building and the complete address for the building
- **Building size:**
  Including the typology (single-family house, terraced houses, multi-family houses, apartment blocks), some elements about the construction material of the building, the number of floors, the net floor area, the energy carrier.
- **Number of inhabitants:**

1 Institut Wohnen und Umwelt (2012), TABULA project IEE/08/495, Deliverable: Typology Approach for Building Stock Energy Assessment. Main Results of the TABULA project: Final Report Appendix volume, 2012.

- **Construction period:**
  Including also the period for the implementation of the ESM.

Please refer to the Handbook to have a better overview of the main statistics regarding average values for the different parameters in the construction period.

The parameters included in the Factsheets are simple indicators. **A more complete description of the building is provided for the 18 buildings inventoried and selected as Pilot Sites for the second phase of the project**. Concerning these buildings, a detailed assessment of the systems and more structural values will be provided.

III.2.B.b. Description of the ESM

The description of the Energy Saving Measure is based on theTypology list included in the Scientific methodology of the project. Its ambition is to set the measure in the corresponding categories included in the Typology list. More details will be added (when available) by the participating SHOs concerning some details and performances.
As AFTER is garthering very different energy saving measures, it was difficult to provide one single model for the « Description of the ESM » part. Scientific partners have decided to focus on some answers that will have to be provided :

- **what part of the building/system/equipment is impacted by the Energy Saving Measure**.
- **what is the technical/human principle** for the ESM
- **what are the key figures regarding the new measure implemented,** especially when we are focusing on a very technical ESM (thickness of a new insulation, performance and type of a new boiler, etc.).

III.2.B.c. Data basis

The data basis presents the **key figures to understand the performance for a single ESM**. This data basis is often quite difficult to complete for the Social Housing Organizations as the data is sometimes very dispersed or missing.
Mainly focused on professional aspects, AFTER has integrated this constraint. The project mainly focus on the mos important data to the general performance for one Energy Saving Measure.

The **main performance indicators required** are :

- **the cost for investment :**
  Provided in order to assess the cost for one ESM and to evaluate (regarding the energy savings measured) what may be a potential time for return on investment.
- **energy consumptions for heating:**
  Provided in order to assess the energy savings before and after the ESM. At least, one year of baseline before the implementation of the ESM and one year of reporting after the implementation of the ESM. The objective of this assessment is to conclude with a percentage of energy savings ajusted with the heating degree day for the area. Energy consumptions for Domestic Hot Water will be added when the measure implemented will request more figures on water in order to assess its efficiency.

Optional indicators will be added when possible:

- **energy costs for heating:**
  When provided by the participating SHOs. When these costs will not be provided, please refer to the Handbook of the project which will provide simple pieces of information regarding the evolution for the energy prices in the concerned countries of the AFTER project.
- **maintenance costs:**
  When these costs will be necessary to understand the price for a measure. This indicator will be particularly use in the WP7 concerning low-energy-buildings in order to assess the yearly costs for a specific equipement.
- **additional initial costs:**
  When a specific ESM is linked with costs that can't be considered as initial investment but have to be identified in order to assess it.

All these indicators are collected in the Scoreboard of the AFTER project enclosed as an introduction to the Inventory. The Scoreboard presents the results in terms of costs and savings for every one of the 84 inventoried Factsheets.

The Figure 4 proposes an example of Factsheet provided by the Czech Social Housing Organization MRA sro. and included in the package « Recently Refurbished Buildings ».

 Jedlova 2, Havirov, CZECH REPUBLIC - **Panel apartment building, tower house, external walls made from panels**	**Number of dwellings** 60 **Number of floors** 12 **Heated surface** 3160 **Inhabitants** 130	**Windows replacement** **Replacement of old wooden windows with plastic ones with U←=1,4 W/m2K)**	**Investment & initial costs**	248 074 EUR
			Energy costs for heating	2007 - 22 516 EUR 2008 - 22 807 EUR 2009 - 22 938 EUR 2010 - 27 295 EUR
	year of construction: 1992 **year of implementation of the ESM:** 2008 **energy carrier:** black coal		**Heating energy consumption**	2007: 410 800 kWh 2008: 395 000 kWh 2009: 353 920 kWh 2010: 429 760 kWh

I BUILDING DESCRIPTION I ESM DESCRIPTION I DATA BASIS I

Figure 4 : Example of Factsheets concerning the refurbishment of existing buildings and dedicated to the intervention : « Windows Replacement ».
The left part of the table is dedicated to the complete description of the building and its main formal characteristics.
The central part is dedicated to the Description of the ESM with the instructions on the performances for the new windows installed.
The right part is the data basis with the investment costs, energy costs and evolution of the energy consumptions for heating in kWh per year.

IV. SCOPE AND LIMITS FOR THE INVENTORY APPROACH

The **Inventory as expected in the original definition of the project has been sometimes difficult to complete due to several reasons**. **AFTER partners have adapted this deliverable regarding the limits identified by the operational partners: the participating Social Housing Organzations**.

This part of the Introduction presents the **main difficulties identified during the process** and provides some clues to understand them in the general approach carried out by the AFTER project. As a conclusion, the Inventory (and its limits) need to be repositioned in the general architecture of the AFTER deliverables.

IV.1. INTERDEPENDANCE AND REPRESENTATIVENESS OF THE ENERGY MEASUREMENT

IV.1.A. Systems complexity

As mentioned in the Introduction**, the system complexity of the buildings can be an obstacle to assess and to individualize the performance of a single energy saving measure**. The efficiency for a measure implemented on one system or part of the building may be offset by some degradations on another part of the building.

Concerning global refurbishments and low-energy buildings, the performance for the energy saving measure is often easier to identify as the building is globally concerned.
Regarding some more punctual interventions, such as some changes/replacement of elements on a boiler, the effective impacts may be more difficult to assess.
The new performance can be reduced by other disorders. For example, the expected performance regarding the change for circulation pumps can be easily deleted by defects of insulation around windows, badly insulated networks or energy-conusming behaviors.

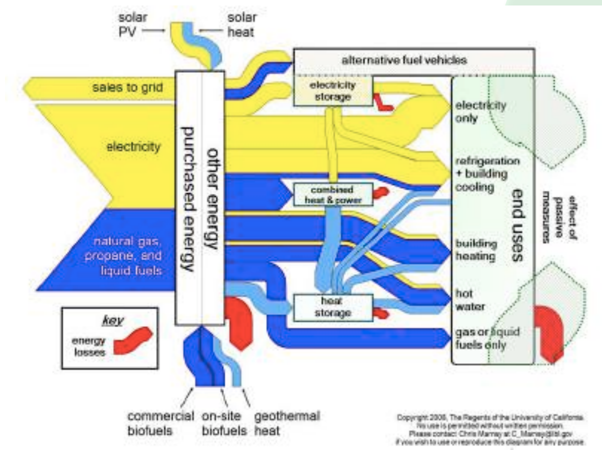

Figure 5. Schematic of the Energy Flow Model
© University of California

The heterogeneity and the complexity of relationships between the systems adds one part of uncertainity to the evaluation of the performance for one energy saving measure[1].

The AFTER team has been challenged by these types of issues. Social Housing Organizations have been trying to collect some measures with concrete results. The selected buildings have been identified in order to limit the risks of any negative externalities due to other disorders.
Scientific partners have also prevented some unexpected and irrelevant deviations. Energy figures provided by the participating Social Housing Organizations have been completed by some data identified in the existing scientific litterature.

IV.1.B. Human factor

The **data compiled in the Inventory is also depending on the tenants reception for an energy saving measure**. This integration of the behaviroal aspects correlated to one measure can be tackled regarding two points :

- **the difficulty to provide simple and validated social indicators regarding satisfaction.**
  The time to implement the Inventory has been very short. As a consequence, the evaluation of the social reception for one measure was difficult to implemented. There are simple indicators to measure this satisfaction and the direct feedback from the SHOs staff about tenants complaints are the main basis to have clues on this socalled social performance.
  This measurement of widespread outcomes for some energy saving measure is a particular stake for the future[2]. Our testing on 18 Pilot Sites will partly enhance the measurement for such factors.

- **the counter-effect of the tenants behaviors on the potential effectiveness of the measure.**
  Behaviors can modify the general performance for one energy saving measures (degradations of the systems by the tenants, opened windows reducing the thermal efficiency for a building, higher indoor temperatures, etc.). It was difficult to observe for every building inventoried in this deliverable, what may be the potential impact of the tenants behaviors on the performance for the implemented ESM[3].

IV.1.C. Repeatability of the reported Energy Saving Measures

The energy saving measures inventoried by the partners display a slighlty unbalanced perspective. The number of 4 ESMs per work package and per country has been respected.
Nevertheless, it is easy to notice that **some recurring measures have been listed by the participating partners**.
Indeed, **participating SHOs have often tested limited number of different ESMs during the reference period 2006-2011**. Due to this, we have collected meet some smilar or repeated ESMs from one country to another and within a same organization.

This repeatability can't be overcomed but will be useful to highlight several scenarios and experiences concerning a same type of intervention. This repetition has also been fruitfull to gather diverse feedbacks in order to build the recommandations lists for every single energy saving measure.
The data collected for a same type of scenario will also provide better information on the stability and constancy for the performance and its adaptation in heterogeneous buildings and contexts.

IV.2. PREPARATION OF THE FINAL SELECTION

IV.2.A. The Inventory, a general overview

As a conclusion, the AFTER Inventory offers a pedagogical state-of-the-art regarding the most accessible and the most validated by the experience Energy Saving Measures.

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1 Stadler Michael, Marnay Chris, Siddiqui Afzal, LaiJudy, Aki Hirohisak (2009). Integrated Building Energy Systems Design Considering Storage Technologies, presented at the European Council for an Energy Efficient Economy 2009 Summer Study, La Colle sur Loup, Côte d'Azur, France, 1-6 June 2009.

« *Current piece meal practices in system design are not very useful to find the optimal solution. The energy flows in a building are complex enough that it is not possible to find the best economic as well as environmental solution by trial-and-error approaches, and therefore, integrated approaches that consider the whole set of possible technologies are necessary.*"

2 Ryan Lisa, Campbell Nina, Spreading the net: the multiple benefits of energy efficiency improvements, International Energy Agency, Paris, 2012.

« *There are serious consequences to under- or over-estimating the outcomes of energy efficiency. If improving energy efficiency achieves much more than just reducing energy consumption and delivers much wider public benefits, perhaps we should be investing more in it. On the other hand, since climate change mitigation strategies lean so heavily on energy efficiency improvements to reduce energy consumption, confidence that energy efficiency strategies can deliver the energy savings expected is needed. The benefits attributed to energy efficiency are multiple and range from localised benefits, such as energy affordability, social development and improved health and wellbeing, to sectoral benefits, such as industrial productivity, improved asset values and reduced environmental damage. Economy-wide outcomes such as energy security, national competitiveness, greenhouse gas emissions mitigation and poverty alleviation in both developed and developing countries, are also attributed to energy efficiency measures. Energy efficiency specialists tend to focus solely on energy-related outcomes when evaluating the impacts of energy efficiency programmes. Professionals in other fields are unlikely to consider energy efficiency improvements as relevant to achieving outcomes in their own area of concern. Without interdisciplinary cooperation, the extent to which two different sets of interests might overlap is difficult to discern and it is fully possible that the non-energy saving outcomes from energy efficiency might never be fully examined.*"

3 BewareE project IEE/07/242, Developing and implementing effective household energy awareness services, 2012.

« *This discrepancy between knowledge, attitude and behaviour has been referred to as the"attitude-action-gap". A recent pan-European survey (LogicaCMG 2008) revealed that, on average, Europeans carry out only 1.4 out of 6 selected key energy saving behaviours in their homes. Overcoming this attitude-action-gap is one of the challenges of the climate change agenda. Human behaviour is complex and hard to predict. It does not follow the typical deterministic models of scientific law (such as Newton's Law of Gravity) that gave rise to the success of the natural sciences. However, because this "technical" approach to problem-solving is deeply rooted in our modern, rationalised, specialised society, it is difficult to understand the complexity, uncertainty and fuzziness of human behaviour and how and why it changes.*"

The inventoried measures cover the 5 work packages which decline the main potential investment concerning the managament and the maintenance of the Social Housing Stock.

Moreover, the **Inventory offers a relevant diversity of contexts and actions that will prepare the second phase of the projet**.

Indeed, the **inventoried measures tackle the following items**:

- an **extended range of energy carriers with a priority to gas but also integrating carriers from solar energy or black coal.**
- a **variety of typology from apartment blocks of the 60's (« Panel in Czech Republic or « Grand ensemble » in France) to Passivhaus and high performant energy buildings for ederly or students in Denmark and Germany**.
- several **timelines including very punctual and technical interventions and longer-term campaigns** adressed toward tenants.

IV.2.B. A representative selection of 18 Pilot ESMs

The work done during the Inventory period is the first step to select the 18 Pilot Energy Saving Measures that will be tested during the second phase of the project.
These 18 Pilot ESMs will be analyzed more in detail regarding their maintenance and management aspects. Their costs will be detailed and their impacts on the concerned Pilot Sites will be deepen thanks to an exhaustive scientific analysis.
Furthermore, optimization solutions will be proposed in order to improve and to strengthen the economic, energy and social efficiency for these types of interventions.

The selection of the 18 Pilot ESM is directly connected to the conclusions of the Inventory.
The objective is to keep, among the 84 Factsheets included in the Inventory a good panel of the most relevant measures for the European Social Housing Organizations.
The **Inventory is a raw data basis gathering some repetitive or some well-identified measures**. The **18 Pilot ESMs will refine the general blueprint of the Inventory operating a selection process regarding the main concerns of the participating Social Housing Organizations**.

This next phase of the project will allow to correct and re-orientate some deficiencies of the Inventory.
A particular effort will be carried out in order to propose:

- **a coherent ensemble.**
  Including measures targeting the main topics regarding energy savings with a particular focus on the efficiency of the heating systems. These measures will target the wide range of buildings and systems included in the Inventory. They will try to respect, as much as possible, the general proportions and balance of the Inventory.

- **a representative and innovative collection**
  The Inventory is gathering two families of measures. Some of them are well-know by the practioners but still need some feedbacks regarding some particular aspects (improvement of the energy efficiencies, corrections, supervision of the maintenance). Other measures are more innovative and still need to be integrated in the practices of the professionals. The18 Pilot ESMs selection must keep a balance between these two families in order to bridge the gap between the existing knowledge and routines and the future trends that will impact the everyday practice of the social housing sector.

The **Conclusion of this deliverable presents the main outputs reached by the partners after the Inventory. It introduces and justifies the 18 Final Pilot ESMs selection**.
Principles and justifications for this selection will be detailed for every selected Measure in the report dedicated to the assessment of the implementation on Pilot Sites.

INVENTORY

FACTSHEETS SUMMARY

Country	City	Built in	Dwel.	ESM in	Energy saving measure identified	Investment	Energy Measured parameter	% of savings
OPERATING MANAGEMENT								
SI	Trbovlje	1976	45	2008	Implementation of heat cost allocators to monitor individual tenants heating energy consumption.	8 714,58	Ng - kWh (H)	up to -40%
SI	Trbovlje	1952	16	2007	Implementation of heat cost allocators to monitor individual tenants heating energy consumption.	3 673,91	Ng (Dh) - kWh (H)	from -14% to -51%
SI	Trbovlje	1985	54	2009	Implementation of heat cost allocators to monitor individual tenants heating energy consumption.	8 822,38	Ng (Dh) - kWh (H)	from -14% to -40%
SI	Trbovlje	1981	38	2009	Implementation of heat cost allocators to monitor individual tenants heating energy consumption.	6 953,98	Ng (Dh) - kWh (H)	up to -36%
SI	Ljubljana	1969	23	2009	Implementation of heat cost allocators to monitor individual tenants heating energy consumption.	3 211,70	Ng (Dh) - kWh (H)	Up to -9%
IT	Turin	1939	161	2010	Implementation of heat cost allocators to monitor individual tenants heating energy consumption.	30 751,65	Ng (Dh) - kWh (H)	- 21%
IT	Turin	1966	28	2009	Implementation of heat cost allocators to monitor individual tenants heating energy consumption.			
CZ	Havirov	1956-1998	cca 7700	since 2006	Measurement of individual heating energy consumption per apartment on the basis of heat cost allocators installed on every radiator, then used to calculate each tenant's heating energy consumption share according to the area of individual apartments.	538 882	Coal (Dh) - kWh (H+DHW)	+ 20%
FR	Angers	1972	20	2010	Tenant handbook provided to every tenant including recommandations on ventilation of the dwellings and heating.	2500	Ng - kWh (H+DHW)	up to -10%
FR	Angers	70's	Cca 220	2011	Awareness process: implementation of a pilot dwelling (3 rooms-70 m2) with an association specialized in energy savings (220 visits in 6 months)	6810	Ng - kWh (H+DHW)	Heat: -83kWh/dwel. DHW: -15kWh/dwel.
CZ	Havirov	1983	65	2007	Control of the functionality of the thermostatic valves on the basis of complaint of tenants or in case of the planned control, exchange of TRVs in whole building. Education of tenants about correct use of TRVs in case of complaints of tenants	33 (TRV installation) 11 (hourly rate for trainer)	Coal (Dh) - kWh (H+DHW)	from -6% to -8%
DK	Copenhagen	1996	140	2006	Climate Ambassadors: Educating tenants (women-network of non-danish background) in energy-friendly and environmental-friendly behavior.	250 per tenant	Ng - kWh (H+DHW)	Heat: -3% DHW: -10%
SI	Ljubljana	1982	88	2009	Subcontractor/ caretaker education. District heating maintenance manual for subcontractors /Training subcontractors to secure that energy savings	100 per tenant	Ng - kWh (H+DHW)	From -15% to -35%
DK	Herning	2009	66	2009	First Social Passive Housing building in Denmark. Tenant information about heating system and tips/motivation in written form are delivered. This awareness process is supplied by direct information from local staff.	6 213 200 (new construction)	El. + Geotherm- kWh (Overall)	Energy performance: 39,63kWh/m2/y to 42,42kWh/m2/y

FR	Angers	1997	20	2006	Regular electric load-sheddings managed by a subcontractor	711,89/dwel.	El. - kWh	Cca - 570kWh/dwel./y
FR	Angers	1963	40	2009	Contract review aimed at decreasing the operation costs of central heating &nd hot water heating installations.	572, 73 (engineer consultation)	Ng - kWh (H)	From -15% to -17%
FR	Angers	1964	68	2009	Contract review aimed at decreasing the operation costs of central heating &nd hot water heating installations.	572, 73 (engineer consultation)	Ng - kWh (H)	From -2%% to -6%
DE	Darmstadt	1960	40	2010	Monitoring of the heating system: Installation of the "Adapterm module" to control and adapt the supply temperature of the heating system.	1100/dwel.	Ng - kWh (H+DHW)	From -6% to -24%
DE	Darmstadt	1980	8	2010	Monitoring of the heating system: Installation of the "Adapterm module" to control and adapt the supply temperature of the heating system.	1100/dwel.	Ng - kWh (H+DHW)	Up to -18%
IT	Italy	1995	51	2010	Monitoring of the heating system: Installation of the "Adapterm module" to control and adapt the supply temperature of the heating system.	94 050	Ng - kWh (H)	From -14% to -17%
IT	Italy	1995	51	2010	Monitoring of the heating system: Installation of the "Adapterm module" to control and adapt the supply temperature of the heating system.	103 050	Ng - kWh (H)	From -14% to -27%
FR	Angers	1985	100	2009	Online monitored hot, cold and central heating water metering for tenants with website access and maintenance fee.	Implementation: 202,3/dwel. Maintenance: 26,8/dwel. Website: 3/dwel/y	Ng - kWh (H+DHW)	From -18% to -15%
CZ	Havirov	1962	36	2005	Web portal created to increase the awareness and the involvement of the tenants regarding the management and the visualisation of their water and heating energy consumptions.	6388	Coal (Dh) - kWh (H+DHW)	Up to -9%
RUNNING MAINTENANCE								
CZ	Havirov	1983	66	2007	Hydraulic balancing: Regulation of pressure: From 243 valves it has been exchanged 149 type of head, in the basement manual regulation valve, differencical pressure regulator including installation.	11 458	Coal (Dh) - kWh (H+DHW)	from -4% to -6%
CZ	Havirov	1962	36	210	Hydraulic balancing of the heating system and installation of the thermostatic valves (New regulation and closing valve type, closing valve type installed on the other vertical pipelines on supplied pipes, differential pressure regulator type, regulation valve, in connecting point, new TRVs.	11 862	Coal (Dh) - kWh (H+DHW)	up to -6%
SI	Trbovlje	1970	52	2010	Hydraulic balancing: connecting valves were built-in on return flow line. Balancing valves were installed, in all apartments radiator valves were switched for new thermostatic valves with additional fine regulation.	12 000	Ng (Dh)- kWh (H+DHW)	from -12% to -13%
FR	Angers	1969	85	2010	Installation of valves on all heating columns	76 066	Ng - kWh (H)	up to -7%
SI	Trbovlje	1951	14	2009	Change of regulation in district heating station: analog regulator was changed with digital regulator and district heating station was connected to remote control	5000	Ng (Dh)- kWh (H+DHW)	From -7% to -13%
SI	Ljubljana	1996	140	2010	Change of regulation in common heating station.	3200	Ng (Dh)- kWh (H+DHW)	From -11% to -15%

DE	Darmstadt	1973	24	2009	Exchange of the heating circulating pumps including mixers and sliders.	12 600	Ng - kWh (H+DHW)	from -2% to -7%
SI	Ljubljana	1967	68	2010	Replacement of a circulating pump in heating station	2065	Ng - kWh (H+DHW)	from -2% to -4%
DE	Darmstadt	1968	20	2008	New torch for the natural gas heating system	3148	Ng - kWh (H+DHW)	from -4% to -6%
SI	Ljubljana	1925	12	2010	Thermal insulation of heating pipes in the unheated common areas	134	Ng (Dh)- kWh (H+DHW)	From -10% to -18%
SI	Ljubljana	1991	38	2010	Cleaning two boilers (removing sediment, dirt…)	1329	Ng - kWh (H+DHW)	From -3% to -5%
DE	Darmstadt	1972	44	2006	Replacement of of hot water tank with a central heating system : exchange of the hot water tank with a better insulation	9 100	Ng - kWh (DHW)	- 50%
CZ	Havirov	1956	32	2010	Old steel hot and cold water pipes replaced with new, insulated plastic pipes.	58 927	Coal (Dh) - kWh (H+DHW)	From -6% to -30%
CZ	Havirov	1992	32	2010	New water distributions are plastic and insulated.	8 996	Coal (Dh) - kWh (H+DHW)	Up to -23%
CZ	Havirov	1961	36	2009	Replacement of CW, HW main water pipes. Replacement of horizontal pipes, pipes in flats and waste pipes.	49 692	W – m3 (DHW)	Up to -5% (DHW) Up to -6% (DCW)
FR	Angers	1966	25	2010	Individual natural gas boilers : draining of heating pipes / draining and injection sludge remover product.	132,1/system	Ng - kWh (H+DHW)	- 60 to 62 kWh/sm/year
FR	Angers	1978	58	2008	Installation of Eco-Techniques 2070 kits including : a 5 l/mn or 10 l/mn dual flow frother on kitchen sink's taps ; a 5 l/mn frother on washbasin's taps , a 7 l/mn shower head ; 2 toilet tank's leak chips.	10 475	Ng - kWh (DHW) W – m3 (DHW)	Energy for Hot Water: -11% Quantities for HW : 2009: -12%
DK	Copenhagen	1980	56	2010	Installation of water-efficient heads and aerators for showers and faucets.	4000	W – m3 (DHW)	- 7%
FR	Yvetot	various	10 336	Since 2008	Implementation on the occasion of the visit of maintenance valves, aerators on all faucets of its housing stock.	3 to 9/dwel.	W – m3 (DHW)	- 4%
FR	Angers	1981	114	2009	Installation of 360° array lighting sensors (6 units) in garages in place of permanent lighting (46 bulbs of 20 W each)	3004	El. - kWh (Lighting)	- 11%
REPLACEMENT OF SYSTEMS								
IT	Beinasco	1982	105	2009	Installation of 2 new condensing boilers	130 750	Ng - kWh (H)	- 5%
IT	Rivoli	1972	24	2010	Installation of a New condensing boiler:	35 560	Ng - kWh (H)	- 26%
IT	Torino	1978	12	2009	Installation of a new Condensing boiler	36 600	Ng - kWh (H)	From -22% to -23%
IT	Torino	1984	96	2009	Installation of a new Condensing boiler	85 000	Ng - kWh (H)	From -12% to -32%
DE	Darmstadt	1969	32	2009	Replacement of two central standard boiler from 1990 with 2 low-temperature boilers with an output of 480 kW including hot water	74 900	Ng - kWh (H + DHW)	From -13% to -27%

DE	Darmstadt	1957	30	2010	Replacement of boiler with a central standard boiler from 1982; new gas calorific value boiler and adaption of the performance : modulating gas-condensing boiler	19 900	Ng - kWh (H + DHW)	From -9% to -43%
DE	Darmstadt	1957	5	2011	Replacement of two central standard boiler from 1990 with a new low temperature boiler and adaption of the performance.	12 376	Ng - kWh (H + DHW)	- 20 %
DE	Darmstadt	1956	17	2008	With a central boiler from 1981 only for heating, new low temperature boiler only for heating and adaptation of the performance	21 539	Ng - kWh (H)	From -7% to -23%
FR	Angers	1975	42	2006	Replacement of boiler, with a with 1 condensation boiler and regulation	106 581	Ng - kWh (H)	Up to -11%
FR	Angers	1992	21	2009	Improvement of natural gas boilers (with thermostat and pilot flame) with low temperature, accumulation boilers, improvement of thermostats	37 555	Ng - kWh (H)	Individual boiler (various)
FR	Angers	1954	18	2011	Improvement of 13 natural gas boilers with low temperature, micro-accumulation boilers, installation of thermostats	7 825	Ng - kWh (H + DHW)	Individual boiler (various)
DE	Darmstadt	1983	25	2009	Exchange of the district heating station and the hot water tank with a better insulation. District heating with clear in store system and a power of 160 kW.	19 000	Ng - kWh (H + DHW)	From -9% to -32%
SI	Trbovle	1968	82	2008	Replacement of district heating substation. Old heating sub/station was removed, new heating sub/station was installed (regulations, pumps, calorimetres, accumulators, electrical installation, safety…)	32 823	Ng - kWh (H + DHW)	Not relevant
SI	Trbovlje	1980	84	2007	Replacement of district heating substation. Old heating sub/station was removed, new heating sub/station was installed (regulations, pumps, calorimetres, accumulators, electrical installation, safety…)	36 133	Ng - kWh (H + DHW)	From -22% to -33%
SI	Trbovlje	1983	169	2007	Replacement of district heating substation. Old heating sub/station was removed, new heating sub/station was installed (regulations, pumps, calorimetres, accumulators, electrical installation, safety…)	38 195	Ng - kWh (H + DHW)	From -4% to -14%
SI	Trbovlje	1990	32	2010	Replacement of district heating substation. Old heating sub/station was removed, new heating sub/station was installed (regulations, pumps, calorimetres, accumulators, electrical installation, safety…)	14 524	Ng - kWh (H + DHW)	- 17%
SI	Ljubljana	1963	6	2010	Installation of a central heating with a renewable energy source, old oil boiler was replaced with new heat pump air-water	14 000	Air/Water – kWh (H)	- 68%
FR	Balleroy	1983	4	2010	4 individual houses where electric heating has been changed for heat pumps.	50 197 (including also ventilation and plumbing)	Ground – kWh (H)	- 11%
SI	Ribnica	1985	25	2010	Replacement of old oil boiler with wood biomass district heating system, old boiler was replaced with new bolier, energy source is wood, district heating	Not provided	Wood (Dh) – kWh (H+DHW)	From -24% to -48%
SI	Mislinja	1983	10	2010	Old boiler was replaced with new biomass boiler, energy sources are pellets	23 895	Wood – kWh (H+DHW)	- 55%
FR	Castelnaudary	70s	229	2008	Wood-burning boiler using wet wood blocks 55% H20. Power : 560 kW+ 2 gaz boilers. Power : 2880 kW	560 500		
FR	Carcassone	80s	348	2008	Wood-burning boiler using wet wood blocks 55% H20. Power : 960 kW+ 2 gaz	857 000	Wood/Ng –	

					boilers. Power : 2880 kW		kWh (H+DHW)	
RECENTLY REFURBISHED BUILDINGS								
FR	Angers	1974	88	2010	External insulation (gables and roof)	47 348	Ng - kWh (H + DHW)	From -14% to -21%
FR	Angers	1977	78	2009	Flat roof insulation	44 484	Ng - kWh (H + DHW)	From -6% to 20%
FR	Angers	1975	58	2009	New windows with double heat protection glass and Ceiling insulation	Windows: 276461 Ceiling : 19 828	Ng - kWh (H + DHW)	Up to -27%
FR	Angers	1976	107	2010	Flat roof insulation Replacement of electric heating ceilings with electric radiant heating floors	Flat roof : 215 420 Electric ceilings : 525 558	El. - kWh (H)	Up to -9%
FR	Angers	1977	133	2011	Flat roof insulation Replacement of electric heating ceilings with electric radiant heating floors	Flat roof : 313 419 Electric ceilings : 664 765	El. - kWh (H)	Not relevant (overconsumption)
FR	Angers	1977	28	2011	Flat roof insulation	8 011 + 14,134.68 (removal and preparation of floor) +10,778.82(tightness	Ng - kWh (H + DHW)	Up to -6%
FR	Clermont-Ferrand	1967	152	2010	External shell insulation + Ventilation + Windows	3 356 177	Ng - kWh (H + DHW)	cf. ESM BERGSON - 8%
FR	Clermont-Ferrand	1965	126	2012	External shell insulation + Ventilation + Windows	Not provided	Wood + Ng (Dh) - kWh (H + DHW)	cf. ESM AIGUILLADE - 32%
CZ	Havirov	1970	72	2008	Insulation of building envelope, roof and exchange of windows	1 419 367	Coal (Dh) - kWh (H+DHW)	From -16% to -25%
CZ	Havirov	1962	36	2009	External shell insulation +) Windows	590 222	Coal (Dh) - kWh (H+DHW)	Up to -25%
CZ	Havirov	1992	60	2008	Windows replacement	248 074	Coal (Dh) - kWh (H+DHW)	From -10% to -12%
CZ	Havirov	1963	54	2009	Windows replacement	176 751	Coal (Dh) - kWh (H+DHW)	Not relevant (overconsumption)
CZ	Havirov	1960	34	2010	External thermal insulation	590 221	Coal (Dh) - kWh (H+DHW)	From -4% to -26%
SI	Trbovlje	1990	31	2009	Concrete building with 6cm insulation additionally insulated with 7cm insulation	717 74,54EUR	Ng (Dh)- kWh (H + DHW	Up to -17%
SI	Trbovlje	1961	20	2009	Brick walls building with no insulation insulated with 10cm insulation.	509 74,6	Ng (Dh)- kWh (H + DHW	From -9% to -20%

SI	Ljubljana	1981	20	2009	External insulation of the facade with 80 mm of styrofoam (Extruded polystyrene foam XPS)	35 000	Ng (kWh (H + DHW	From -18% to -21%
SI	Ljubljana	1984	96	2009	External thermal insulation with 10 cm of styrofoam in concrete prefabricated building with flat roof and balconies.	163.000	Ng (kWh (H + DHW	From -12% to -26%
DK	Lystrup	1984	14	2010	14 houses for senior housing from 1984 are going through a total renovation to upgrade it to a lowenergi housing	2.984.390	Ng (Dh) + El - (kWh (H + DHW	Up to -36%
DE	Darmstadt	1953	30	2007	New heating system with a low temperature central boiler + Insulation of the roof with no previous insulation on the roof.	1 414 478	Ng - kWh (H + DHW	From -50% to -56%
DE	Darmstadt	1951	30	2008	A building from the 50th with no insultion on the facade. Insulation of the facade (30 cm). Insulation of the cellar ceiling (10 cm)	Facade: 70 560+10 584 Ceiling: 8000 +1200	Ng - kWh (H + DHW)	Up to -80%
DE	Darmstadt	1953	20	2010	A building from the 50th with no insultion on the facade. Insulation of the facade (14 cm).	1 136 901	Ng - kWh (H + DHW)	Up to -45%
DE	Darmstadt	1955	20	2008	A building from the 50th with no insultion on the facade. New heating system with a low temperature central boiler + external insulation of the facade	110 371	Ng - kWh (H + DHW)	Up to -75%
IT	Veneria Reale	1966	28	2009	Windows substitution: Existing single glazing were substituted with aluminum windows with double glazing and shutters in PV. Implementation of a insulated coat of 80mm applied on this existing building of the 1960's.)	Cf ESM PICCO		
IT	Torino	1978	40	2011	External insulation, window substitution. Pre-fabricated building with no insulation has been equipped with external double skin wall having 100mm insulation.. Single glazing windows have been substituted with double glazing high performance windows.	5 271 959, 48 EUR (with Via Parenzo 55)	Ng - kWh (H + DHW)	Not provided by the SHO
IT	Torino	1978	44	2011	External insulation, window substitution. Pre-fabricated building with no insulation has been equipped with external double skin wall having 100mm insulation.. Single glazing windows have been substituted with double glazing high performance windows.	5 271 959, 48 EUR (with Corso Molise)	Ng - kWh (H + DHW)	Not provided by the SHO
FR	Bourdainville	1973	7	2011	External insulation . Insulation between home and garange. Insulation of the attic. New hygro-B ventilation controlled system Heat pump air/water + thermostatic valves	Not provided	El. Air/water - kWh	Up to 67%
FR	Autretot	1974	12	2012	External insulation . Insulation between home and garange. Insulation of the attic. New hygro-B ventilation controlled system Heat pump air/water + thermostatic valves	552 000	El. Air/water - kWh	Up to 73%
FR	St-Martin d'Hères	1955-1958	36	2012	External insulation. Flat roof: insulation. Attic insulation. Double-glazzing windows Uw=1,4W/m2.K. MCV system hygro B. Connected to district heating. Radiators with thermostatic valves.	816 696	Ng (Dh) - kWh	Up to 72%
DK	Hyldespjælde	1976	1	2009	Complete renovation to low-energy building (experimental project)	401 651	El. Solar. Ground – (Overall)	Heating: - 112 kWh/m2/y Electricity: - 24 kWh/m2/year
DK	Albertslund	1965	1	2011	Complete renovation to low-energy building (experimental project)	135 949	Ng - kWh (H + DHW)	Up to -37%

RECENT LOW ENERGY BUILDINGS

(particular structure cf. report for explanationr regarding the methodological explanations – every sub-factsheet concerning the detailed performance for: General Overview - Insulation-Windows-Supply systems-Ventilation) are then detailed with the correspond parameters and figures leading to the requested 12 Factsheets

SI	Trbovlje	2006	13		**Building designed and built in accordance with old Slovenian national "Rules of Thermal Insulation and Efficient Energy Use in Buildings" - cf. Handbook. 10cm EPS shell insulation, min. 10cm EPS roof/ceiling insulation and 8cm EPS basement floor insulation. Double glazed windows. No heat recovery or ventilation systems. Connected to local district heating system (Ng)**	891 829, 69	Cf Heating Consumption	2008 : 58.4 kWh/(m²a) 2009 : 56.8 kWh/(m²a) 2010 : 67.8 kWh/(m²a) 2011 : 61.8 kWh/(m²a) 2012 : 50.3 kWh/(m²a) 2013 :49.1 kWh/(m²a)
DK	Maarslet	2011	8		**Terraced houses for elderly people. Low energy Kl.1 according to danish BR98. Insulation 445mm / Roof, Insulation 200mm / Walls, Insulation 300mm / Foundation, Windows & Frames / Insulation, Windows & Frames (U=1,20 w/m2*k incl. frame and sash) / Sun Protection, Photovoltaics (Solar panels on the roof 7.66 per m2. house (0.154 kW/m2 Peak power and system efficiency of 0.752), Ventilation and heat recovery & District heating. Energy carriers: 2013 Approx. 40% biomass (mainly straw and domestic waste) and 60% coal**	808 500, 00	Cf description Overall Consumption	2011: 82 kWh/m²a 2012: 114 kWh/m²a
GE	Darmstadt	2010	44		**Passive house standard planned in PHPP with a Insulation of the facade with 30 cm EPS, double flow ventilation system and triple Heat protection Glass. District heating system. Electric warm water tank.**	5 896 000	Cf description Heating + DHW	2011 : 37.6 kWh/(m²a) 2012 : 40.9 kWh(m²a) 2013 : 40.8 kWh/(m²a)
FR	Betheny	2010	13		**External thermal insulation of 30cm. Ground-coupled heat exchanger. Double-flux ventilation. DHW with solar panels. Green roof. Triple-glazing south. Double-glazing for the rest of the building .**	1 963 684	Heating + DHW+ electricity+auxiliaries	2011: 87 kWh/(m2.a) HDD: 2567 2012: 73,43 kWh/(m2.a) HDD: 2455 2013: 93,58 kW/(m2.a) HDD: 2789

REMINDER : HEATING DEGREE DAYS

Using relevant Heating Degree Day data (HDD) in the calculations is an important step in the assessment of the energy savings.

The AFTER project has developed its basis as follows.

HDD are used to calculate so called normalized energy consumption that is making possible to quantify the actual energy savings, by taking into account the variability of climatic conditions in different years.

National - or better - local HDD are applied.
In most of EU countries the HDD can be downloaded from the web pages of national meteorological institutions by selecting the nearest station data. In some countries these data are not accessible to the public. In such cases it is possible to use at the data from local district heating company' or other energy suppliers.

EUROSTAT HDD data are used to compare the efficiency of energy saving measures at the European level. Taking this into account, Eurostat launched a project aiming at the development and implementation of a common method for the climatic correction of final energy consumption in the 27 Member States of the European Union. Temperature corrected energy consumption data helps the interpretation of energy consumption trends. Unfortunately for the time being EUROSTAT monthly data for EU 27 NUTS 2 regions available only until 3/2010.

To calculate the normalized energy consumption following data is needed:

- **Monthly energy consumption** in kWh for the baseline period (at least 12 months) and the monitoring period. *)
- **Local monthly HDD** from the baseline and the monitoring period.
- **Monthly average of HDD five years back** (calculate the average by adding the HDD for the same month five years back and divide by five).

In case the monthly energy consumption data are not available, but only the yearly consumption, the yearly consumption can be distributed over the months by using the HDD.
If the monitoring period is 2013-14, the average is found by adding the years 2008-12.

For a new low energy building (=without baseline), the baseline energy consumption is defined and calculated on the basis of the legal demands in the Building Regulations in the baseline period and distributed by means of the HDD.

For an existing building without a known baseline, it is possible to gather the average energy use per m2 from buildings from the same period or from one building from the same period and then calculate the same way as for new low energy buildings.

Please find below the **general formula** and after that **an example is shown on how to calculate on a monthly basis**. More information can be found in the "AFTER Handbook" on the website afterproject.eu.

GENERAL FORMULA:

ECnormalised =(ECperiod / HDDperiod) * HDDaverage

Explanation:
ECnormalised = Energy consumption on the period with HDD correction
ECperiod = Energy consumption on the period without HDD correction
HDDperiod = real HDD on the period
HDDaverage = average HDD defined for a period of several years - e.g. January five years back on monthly basis
Recommanded period = month (else year)

We calculate the monthly HDD normalised energy consumption and sumarize the values to obtain the annual HDD normalised energy consumption (or for a heating period).

	2007	2008	2009	2010	2011	2012	Average
France (Clermont-Ferrand)	2796,1	2373	2353	2721	1979	2211	2516
France (Angers)	2216	2064	2071	2427	1648	2044	2474
Czech Republic (Havirov)	3418,4	3314,4	3335,9	3986,8	3306,82	3494,1	3619,4
Italy (Torino)	2649	2617,7	2864,9	2897,9	2665,5	2689,4	2617
Germany (Darmstadt)	2656,3	3219,3	3132,5	3624,8	2866,4	3218	3089
Denmark (Aarhus)	2570,1	2607,5	2816,8	3309,9	2732,9	2627	2906
Slovenia (Ljubljana)		2883,8	2812,2	3094,2	2852,5	2765,7	
Slovenia (Trbovlje)	2904,5	1819	2723,3	3082,21	2748,2	2728	2502

WP3: OPERATING MANAGEMENT

This work package is specifically dedicated to E.S.M. related to the operating management of the housing stocks by the S.H.O. It focuses on the improvement of the contractual framework of the operating management.

The scope of the WP 3 investigates two dimensions with two different kinds of stakeholders:

1. The contractual relations with the heating providers and the facility management companies:
These contractual ESM can present different forms, AFTER will evaluate the performance of the most recent and the most practiced (e.g.: contract with heating systems maintenance companies including a profit-sharing scheme if contractual energy savings objectives are reached, energy performance contract with third party financing to finance energy savings investments,...)

2. The contractual relations with the end customer (the tenants or the inhabitants) and the energy awareness ESM activities which should be implemented to secure these contractual relations
In most of the E.U. countries, new legislations are adopted which authorize the sharing of the investment costs between the tenants and the SHO when a significant upgrade of the energy efficiency is financed. The contractual relations with the tenants are changing. Some management problems are arising notwithstanding how to guarantee in the contract the energy performance co-financed by the end-users and how these guarantees should be associated with the implementation of Energy Awareness Measures.

Most of these measures have been identified in the frame of the IEE BeawareE project "service inventory"(Campaigns, Consulting for the housing sector, Empowerment, Energy information, Energy monitoring, Exhibitions and events, Face to face advice, Financing and consultation, Low cost incentives, Training forums, Web tools) but neither their efficiency on the long term nor the link with the rent contract has been studied in detail.

Corresponding ICT solutions to improve the energy awareness of the end customers and/or the performance of the operating subcontractors will be studied if their use is a consequence of the ESM (e.g. the monthly invoicing of the customer's energy consumptions).

OPERATING MANAGEMENT

ESM: HEAT COST ALLOCATORS

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Individual billing for energy

INITIAL ISSUE RELATED TO THE ESM
The main purpose of installing heat-cost allocators is to implement a measurement solution to create direct energy saving incentives for the users (tenants).
Heat cost allocators devices provides SHO data for individual energy billing The heat cost allocators implementation answers to the concepts of fairness and equity as every tenant will be impacted regarding its personal use of the heating system.
Thanks to this individual measurement and distribution of the energy consumptions tenants will receive feedback about their personal use for heating.
Therefore, heat cost allocator is supposed to contribute to the energy saving incentive helping tenants controlling and being informed about their heat overconsumptions, if needed.

The empowerment potential for such a measure may be one significant aspect that will motivate the management decision of SHO.
The objective is to encourage the tenants to optimize their heating consumptions and adapt it to a requested need of comfort.
Concerning the global approach of the energy efficiency, the research for additional performance will be oriented toward the tenants' dwellings and their use more than the consumptions on the common parts of the building.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Implementation of heat cost allocators monitors tenants individual heating energy consumption. These individual separated consumptions are then used to calculate each tenant's heating energy consumption share**. Through this ESM, the tenant is supposed to get real information on its own individual consumption and heating costs**. Heat cost allocators are a technical solution to individualize the energy consumption for a proper dwelling. This technical solution is offering an opportunity to reconsider the balance and distribution of the energy consumptions for each dwelling in a collective building for example.

Heat-cost allocators are using various sensors, radiator-mounted or temperature devices in order to calculate the exact amount of energy consumed for a single dwelling.

RADIATOR SURFACE TEMPERATURE:
On each radiator, a wireless device is installed to measure the radiator surface temperature (and the ambient temperature for the two-sensors system).
Indeed**, a distinction has to be made between the one-sensor solution and the two-sensors solution**. A sensor linked to the allocator reads the radiator surface temperature.
Concerning the one sensor device, the radiator temperature is recorded and a fixed room temperature is used to process the consumption. At the opposite, the two sensors solution records the radiator and the room temperatures.
In newer buildings heat cost allocators could not be installed on radiators but on internal building's heating line at the entrance of the dwelling.

A calibration is necessary to process the consumption from the reading of both temperatures.
The **heat cost allocator is equipped with a microprocessor and a display device**. It transmits the measured consumption of each radiator to a central unit. Data are then collected by the ESCO or SHO through a radio receiver without entering in the flat and bill is produced for each dwelling.
Those **devices have to meet the NF EN 834 standard and be approved by an authorized national testing laboratory**.
Heats cost allocators are powered with a lithium battery with a 10 years service life.

ROOM AND OUTDOOR TEMPERATURE SOLUTION:
Two-sensors heat cost allocators measures room and outdoor temperatures and transfers them to a central computer programmed to transform this information towards consumption.
The **accuracy of results depends on the location of the temperature sensors** that must express the fair average room and outdoor temperatures.

HEAT METER
The **heat meters can be used when there is a single point of supply per dwellings (horizontal loop, closed circuit)**. In France, for example, less than 10% of dwellings are corresponding this configuration.
Heat meters indicate kWh energy supplied to each unit. Various technologies are used, the more efficient in the ultra sound one [2].
Those devices have to meet the NF EN 1434 standard and be approved by a authorized national testing laboratory.

OPERATION ASPECTS

Heat cost allocation is a combination of monitoring devices and accounting procedures designed to bill heating energy on the basis of individual use of heat.
The distribution of heating costs is therefore realized according to the heat measured instead of surfaces of dwelling. Each tenant is informed of his individual consumption and may control

Generic feedback shows that savings related to heat cost allocators are about 15% the first year, and then the global economy stabilizes around 10% per year. The savings usually represent 50 to 100 EUR in the energy annual bill of a dwelling. The SHO will have to arbitrate the investment between the heat allocators' implementation (which involve a significant cost) and the other energy saving solutions.

Analysis of 11 AFTER buildings where heat cost allocators were implemented showed average payback of 2 years and average energy savings of 30%.

For radiator surface temperature, the existing scientific literature shows that **an average energy saving for heating consumption from 10 to 15% can be reached respecting the following conditions**:

- The **hydraulic balancing of the heating system has first to be checked**. Actually among the negative consequence of neglect of hydraulic balancing are: non uniform heating through a building's height and length, central regulation of the system is difficult because the heat flow is not distributed properly, a circulation pump which would otherwise be adequate is insufficient.
- The **radiator valves have to work properly**,
- The **thermal quality of the dwellings (insulation, ability to take advantage of the solar gains...) has to be quite homogenous**,
- The **tenants have to be involved** in the approach in order to be aware of the potential benefits,
- The **company in charge of the heat cost allocator implementation have to be competent**.

In a study sponsored by the French national agency ADEME, **the energy saving expected can reach 20% on the condition of a deep change of the inhabitants behaviors that heat cost allocators can favor**.
Heat cost allocators are either purchased or rented. When the rent solution is prefered, it is necessary that the annual cost of the allocator is much cheaper than the energy savings.

TENANTS' EMPOWERMENT ASPECTS

It is necessary regarding some empowerment requirement to respect the following features:

- **Cost allocation is fair**
- **Maintenance of building is efficient**
- **Temperature individual control is possible for tenants**. Therefore, it might be necessary to replace thermostatic valves and to balance the hydraulic system before heat cost allocators are installed.

Usually, energy cost is build from a subscription (fixed part of the cost) and from a consumption basis (variable part of the cost). A low fixed part is more simulating for energy saving but fixed cost has to be paid when a flat is not heated.
The **problem of heat transfer between dwellings has to be considered, especially when dwellings are poorly insulated**.

ATTENTION POINT: heat cost allocators have to be considered with care.
Some negative aspects of the heat cost allocators have to be highlighted. The **heat cost allocators can be counter productive and unfair as some dwellings located in parts of the building with natural heavy heat loses** (example: dwellings with a northern facade or located at the last floor) will be impacted notwithstanding their efforts to reduce their energy cosumptions.
Some **more advantaged tenants can also have free riders behaviors**, using the transfert of energy between the dwellings to reduce their heating consumptions and take advantage of the other appartments.

Heat cost allocator implementation needs a well-prepared information campaign to avoid problems with tenants. Because of transparency reason, the method for heating costs calculation has to be comprehensive for tenants.
Heat cost allocators are not recommended when dwellings in the same buiding have quite different thermal quality: upper floor without insulation, north side flat,...
It was also noticed that tenants were encouraged to stop heating when the dwelling was located in the warmer part of the building.

Overview of the dwellings thermally favor or not.

Differences resulting from the thermal quality of the dwelling can be smoothed considering a fixed cost percentage (30% for example) for the energy consumption share.

The **risk that some tenants stop heating their apartments properly and stole heat from neighbours is real**. Inappropriate behavior of tenants caused the increase of presence of mildews and increase of costs paid by SHO to remove mildews.

TIPS AND ATTENTION POINTS

☑ ELABORATE A LIST OF CONTROL POINTS BEFORE THE DECISION

The SHO will have to control some key points before the implementation of the heat cost allocators system in order to ensure that the system may be efficient.

These SHO may control the quality of its heating networks to prepare an efficient use of the heat cost allocatros and the relevancy of their results. **Performance parameters include the following items**:

- **Balanced temperatures in the dwellings** of the building (with a gap not superior to 3°C).
- **De-sludged networks**.
- **Operationnal thermostatic valves**.

The quality of the building must also be checked in order to have a more controlled approach of the thermal performances of the dwellings. **Performance parameters include the following items**:

- **Insulation of the roof** in order to have a good performance on the last floors of the building.
- **Thermal insulation of the gable**
- **Efficiency of the ventilation in the dwellings** to prevent the condensation issues.

☑ HELP TO HAVE A BETTER EQUITY THROUGH RELEVANT COMPENSATION MECHANISM

The objective for the preparation of heat allocator implementation is to obtain a good balance and some compensation mechanism between the most thermally favorized dwellings and the most unfavorized ones.
The **SHO has to implement solutions in order to improve the equity between these buildings in order not to penalize some tenants and to respect its social mission**.

In order to improve this aspect, the **SHO has to implement the necessary interventions on the building's shell and its systems to correct the deficiencies and heat loses on some points of the building** (flat roof, gables, terraces, etc.).

The **SHO also has to implement some corrections and some weighting factors in order to balance the results collected in the dwellings**.
The principle is to use weighting factors with the dwellings located on the weak points of the building that will allow to balance their consumptions regarding the most favorized buildings.
These factors will have to be integrated by the heat cost allocators service provider and the calculation table will have to be communicated to the tenants' representatives.

☑ CONTROL THE CALIBRATION OF THE RADIATORS

Every heat cost allocator will have to be adapted and calibrated regarding the heater power (that implies to know this power). This task can take some time in order to identify and to list the power for the heaters.

☑ CONTROL IF THE HEATING NETWORK IS ADAPTED FOR THE IMPLEMENTATION OF HEAT COST ALLOCATORS (PART ONE: VALVES)

Valves from the radiator need to be checked; non-operative valves will cause important increase for the energy consumptions. The maintenance requirements concerning radiators valves need to be controlled before the implementation of heat cost allocators.

Thermostatic valves need to be implemented in order to guarantee the good efficiency of the system. The thermostatic valves will help to obtain a constant temperature, as they will adapt the required amount for heat regarding the temperature of the dwelling.

☑ CONTROL THAT THE HEATING NETWORK IS ADAPTED FOR THE IMPLEMENTATION OF HEAT COST ALLOCATORS (PART TWO: BALANCE OF THE SYSTEM)

The hydraulic balancing of the system (cf AFTER WP4 Factsheets describing the process for hydraulic balancing if you need any complementary information on this kind of intervention) allow **to obtain the same level of temperature at the different points of a building and limit problems of heat transferts between the dwellings**.

This balancing will need a special attention and the SHO will have to involve an energy specialist in order to implement a preparatory de-sludging, the implementation of balancing valves for the hydraulic system and valves at the entrance of every radiator.

☑ COACH THE TENANTS IN ORDER TO REACH AN EFFICIENT LEVEL OF PERFORMANCE

Cf. Following factsheets concerning ESMs regarding Tenants Awareness for additional information about such type of process. Tenants involvement is –of course- an essential part for efficiency regarding a system based on the individual behaviours of the tenants. This involvement of the SHO regarding the tenants' empowerment is targeting various objectives:

- To respect the social mission of the SHO and provide the necessary information to the consumer regarding a system that will modify its way to pay for energy.
- To provide empowerment tips in order to adapt its individual behaviour and be more responsible about it
- To prevent heat transfer and "heat vampirism" between most and less favoured dwellings.

SPEKTER	Number of dwellings	Implementation of heat cost allocators to	Investment & initial costs/flat	8.714,58 EUR

Opekarna 20, 20a, Trbovlje	45 (2/3 of the building) **Number of floors** 7 **Heated surface** 2610 **Inhabitants** 87	**monitor tenants heating energy consumption. These individual consumptions are then used to calculate each tenant's heating energy consumption share.**	**Energy costs for heating**	2005 - 13458,70 € 2006 - 14079,20 € 2007 - 11754,55 € 2nd half 2008 - 6106,12 € 2009 - 9138,08 € 2010 - 8920,32 €
	year of construction: 1976 **year of ESM implementation**: 2008		**Heating energy consumption (N: normalized)**	2005 – 324090 kWh **(N: 261825 kWh)** 2006 – 288460 kWh **(N: 309834 kWh)** 2007 – 248380 kWh **(N: 213 960 kWh)** **Average:** **261 873 kWh** 2nd half 2008 – 84680 kWh 2009 – 154480 kWh **(N: 141926 kWh)** 2010 – 162020 kWh **(N: 131 521 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009: 46% 2010: 50%
			Annual cost operation	1.344,07 EUR

SPEKTER poslovanje z nepremičninami **Trg revolucije 24, Trbovlje, SLOVENIA**	**Number of dwellings** 16 **Number of floors** 4 **Heated surface** 1209 **Inhabitants** 33	**Implementation of heat cost allocators to monitor tenants heating energy consumption. These individual consumptions are then used to calculate each tenant's heating energy consumption share.**	**Investment & initial costs/flat**	3673, 91 EUR
			Energy costs for heating	2005: 7391 EUR 2006: 7908 EUR 2008: 5969 EUR 2009: 5373 EUR 2010: 5222 EUR
	year of construction: 1952 **year of ESM implementation**: 2007		**Heating energy consumption (N: normalized)**	2005: 175 580 kWh **(N: 141 847 kWh)** 2006: 161 803 kWh **(N: 173 792 kWh)** **Average:** **157 819 kWh** 2008: 98 162 kWh **(N: 135 020 kWh)** 2009: 93 307 kWh **(N: 85 725 kWh)** 2010: 95 105 kWh **(N: 77 202 kWh)**
			% of energy reduction before/after the implementation of the ESM	2008: - 14% 2009: - 44% 2010: - 51%
			Annual cost operation	516, 50 EUR
SPEKTER	**Number of dwellings**	**Implementation of heat cost allocators to**	**Investment & initial costs**	8822, 38 EUR

Trg revolucije 2a, Trbovlje, SLOVENIA	54 **Number of floors** 14 **Heated surface** 3853 **Inhabitants** 167 **year of construction:** 1985 **year of ESM implementation**: 2009	**monitor tenants heating energy consumption. These individual consumptions are then used to calculate each tenant's heating energy consumption share.**	**Energy costs for heating**	2007: 17 124 EUR 2008: 22 930 EUR 2009: 1st half 14 727 EUR 2nd half 4 540 EUR 2010: 14 054 EUR
			Heating energy consumption (N: normalized)	2007: 362 200 kWh **(N: 312 007 kWh)** 2008: 374 600 kWh **(N: 515 255 kWh)** **Average:** **413 631 kWh)** 2009: 1st half: 225 000 kWh 2nd half: 102 300 kWh **(N: 300 703 kWh)** 2010: 256 000 kWh **(N: 207 809 kWh)** 2011: 1st half: 133 000 kWh
			% of energy reduction before/after the implementation of the ESM	2009: - 27% 2010: - 50%
SPEKTER poslovanje z nepremičninami **Sallaumines 5a, Trbovlje**	**Number of dwellings** 38 **Number of floors** 14 **Heated surface** 2821 **Inhabitants** 110 **year of construction**: 1981 **year of ESM implementation**: 2009	**Implementation of heat cost allocators to monitor tenants heating energy consumption. These individual consumptions are then used to calculate each tenant's heating energy consumption share.**	**Investment & initial costs**	6.953,98 EUR
			Energy costs for heating	last 2 mts 2007 - 4590,58 2008 - 16753,56 1st half 2009 - 10693,55 2nd half 2009 - 3603,66 2010 - 10944,21 1st half 2011 - 6704,34
			Heating energy consumption (N: normalized)	last 2mts 2007 – 96700 kWh 2008 – 273500 kWh **(N: 376 194 kWh)** 1st half 2009 – 206000 kWh 2nd half 2009 – 81200 kWh **(N: 263 862 kWh)** 2010 – 198900 kWh **(N: 161 458 kWh)** 1st half 2011 – 105000 kWh
			% of energy reduction before/after the implementation of the ESM	2009: - 30% 2010: - 57%
			Annual cost operation	1.171,80 EUR
	Number of dwellings	**Implementation of heat cost allocators to**	**Investment & initial costs**	3211, 70 EUR

 **Ulica Iga Grudna 9, Ljubljana, SLOVENIA**	23 **Number of floors** 5 **Heated surface** 1220 **Inhabitants** 43	**monitor tenants heating energy consumption. These individual consumptions are then used to calculate each tenant's heating energy consumption share.**	**Energy costs for heating**	Not provided
	year of construction: 1969 **year of ESM implementation**: 2009		**Heating energy consumption (N: normalized)**	2008: 84 230 kWh (N: 73 078 kWh) 2009: 85 170 kWh (N: 75 775 kWh) 2010: 82 500 kWh (N: 66 710 kWh)
			% of energy reduction before/after the implementation of the ESM	2009: + 4% 2010: - 9%
			Annual cost operation	484 EUR
 **Via Biglieri 44-46-50-52, Turin, ITALY**	**Number of dwellings** 161 **Number of floors** 5 **Heated surface** Not provided by the SHO **Inhabitants** Not provided by the SHO	**Implementation of heat cost allocators to monitor tenants heating energy consumption.**	**Investment & initial costs**	Not provided by the SHO
	year of construction: 1939 **year of ESM implementation**: 2010		**Heating energy consumption (N: normalized)**	2007: 10.907 kWh 2008: 13.094 kWh **(N: 11 360 kWh)** 2009: 15.933 kWh **(N: 14 176 kWh)** **Average:** **12 768 kWh)** 2010: 12.512 kWh **(N: 10 117 kWh)** 2011 jan-aug 7.465 kWh
			% of energy reduction before/after the implementation of the ESM	2010: - 21%
 **Via Picco 53-55-62-64, Turin, ITALY**	**Number of dwellings** 28 **Number of floors** 4 **Heated surface** 1807 **Inhabitants** 58	**Implementation of heat cost allocators to monitor tenants heating energy consumption.**	**Investment & initial costs**	Cf. Pilot ESM PICCO
			Energy costs for heating	
	year of construction: 1966 **year of ESM implementation**: 20088-2010		**Heating energy consumption**	
			Annual cost operation	

MRA housing stock, Havirov, CZECH REPUBLIC	**Number of dwellings** Cca 7700 **Heated surface** 647 835 **Inhabitants** 16 670 **year of construction:** 1956-1998 **year of ESM implementation**: 2006	**Measurement of individual heating energy consumption per apartment on the basis of heat cost allocators installed on every radiator. These individual consumptions are then used to calculate each tenant's heating energy consumption share according to the area of individual apartments.**	**Investment & initial costs**	538 882 EUR
			Heating energy consumption and DHW **(N: normalized)**	2003: 55 848 333 kWh **(N: 54 196 707 kWh)** 2004: 52 924 444 kWh **(N: 51 204 152 kWh)** 2005: 57 638 055 kWh **(N: 54 319 796 kWh)** **Average;** **53 240 218 kWh** 2006: 55 519 722 kWh **(N: 56 606 688 kWh)** 2007: 61 447 500 kWh **(N: 65 060 578 kWh)** 2008: 61 544 444 kWh **(N: 67 207 929 kWh)** 2009: 60 563 055 kWh **(N: 65 709 979 kWh)** 2010: 72 761 111 kWh **(N: 66 055 876 kWh)** 2011: 60 350 000 kWh **(N: 66 055 035 kWh)** **Average:** **64 449 347 kWh**
			% of energy reduction before/after the implementation of the ESM	Comparison between baseline and monitoring: +21%

OPERATING MANAGEMENT

ESM: TENANTS AWARENESS

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Tenant information

INITIAL ISSUE RELATED TO THE ESM
Energy saving measures (especially the one dedicated to the global refurbishment of the buildings) stay on the expectations for a better energy efficiency and a reduction/control of the heating costs.
However, recent feedbacks underline the importance of providing tenants relevant information to ensure and guarantee effective energy management. How people use equipment can have at least as much impact on energy consumption as some very technological interventions. Moreover, they are requested to guarantee that such type of technical measures we be efficient and reach their expected objectives.
several tenants awareness tools that may be implemented to make easier the empowerment regarding energy consumptions
Tenants Handbook
The tenant handbook is a practical guide that compiles any comprehensive information and ressources helping occupants to improve their energy efficiency as well as comfort and health in the dwelling. The manual explains for example how to use equipment such as ventilation or monitoring, how to develop an effective behaviour and how to reduce energy consumption.
Energy campaigns
Major savings can result of energy awareness services when measures for behavioural change become effective. Furthermore, tenants rarely pay attention to energy saving and most of the times they are poorly informed that energy can be saved with ordinary action. As a matter of fact, behavioural change is most likely to be successul when information is provided trough personal advising.
Tenant education includes all kind of actions where an energy expert, often called climate or energy ambassador, offers targeted advices on energy savings. This ESM aims at tackling energy savings and aims at helping tenants in managing heating and electricity consumptions, through intervention of staff specially trained on these issues.
Caretakers training
Although people are more and more aware about sustainable development issues, they do not generally realize how much their behaviour is a determinig factor to improve energy efficiency and ensure its continuity. As a consequence providing an operationnal support and contribute to sensibilize or educate the tenants is essential. In this framework, caretakers have an important role to play by explaining functionality or advising the tenants.

GENERIC ESM TECHNICAL

DESCRIPTION

TECHNICAL ASPECTS

HANDBOOK
Communicating information regarding the energy uses of a building/dwelling is an essential incentive and a prerequisite to adapt the behaviors to a new way to save energy and reduce the consumptions.
Written information and handbooks can be an interesting tool both to increase the awareness of the tenants regarding energy stakes and to deliver a message on the best practices in using a buildng and its systems.

A handbook is a book containing information and aiming at raising awareness about the way to consume energy.
The content of the handbook can evolve and will be very different between the SHOs.
The handbook can long or short; oriented toward equipments and their uses or just very general on energy issues.
It is recommended that the handbook be built both in a paper-based and in an Internet standard.

T**enants handbooks can be disseminated thanks to various formats**:
• **Posters** in the common parts of the buildings (for example hall entrances).
• **Books** distributed to the tenants
• **Websites** or newsletter sent to the tenants
• **Stickers** on the equipments concerned by the behaviours.

The manual provides **tenants some pieces of information and features to the tenants regarding**:
• A **better understanding of how energy is used in the dwelling** and how energy effiency might be improved,
• a **comprehensive use of the energy systems** (ventilation, heating, monitoring...),
• a **global knowledge of energy terminilogy** (energy performance certificate, energy bill...),
• an **ongoing development to further energy savings** (electric appliances, transports...).
The handbook addresses questions on how to run and maintain the different systems. It can also give key opportunities in energy training by providing tools to calculate and quantify greenhouse gas savings for example.

The **typical summary of such handbook** is organised as follow:

• Issues related to energy performance and terminology,

• Rules for equipment use,
• Corresponding maintenance contracts,
• Advising for green behavior,
• Benchmarking tools.

CARETAKERS TRAINING

Major savings can result from energy awareness services when measures for behavioural change become effective. Tenants don't pay enough attention to energy savings potentials. Most of the times they are poorly informed that energy can be saved with ordinary actions.
As a matter of fact, **behavioural change is most likely to be successul when information is provided trough personal advising**. Tenant education includes all kind of actions where an energy expert, often called climate or energy ambassador, offers targeted advices on energy savings. This ESM aims at tackling energy savings and aims at helping tenants in managing heating and electricity consumptions, through intervention of staff specially trained on these issues.

Using caretakers as trainers must be a good complementary action regarding more general trainings. The caretaker will ensure a stand-by contact with the tenants regarding energy topics and will proceed to more punctual information in order to maintain a constant attention.
This intervention means that the **caretakers will have to be both trained and informed regarding the technical aspects of the building he/she has to take care of and about the communication tools to raise the awareness of the tenants regarding energy stakes**.
To strengthen the knowledge of the caretakers both regarding technical and social aspects are a good lever to implement «soft» changing regarding behaviors.

OPERATION & MANAGEMENT ASPECTS

ENERGY CAMPAIGNS

Most of the times, tenant education involves caretakers, social workers or any staff with close contact with tenants.
It is particularly important that climate ambassador can reach and advise tenants easily. If they are not energy expert, **energy ambassadors are trained to get skills in detecting energy waste and in implementing ESM in dwellings**. The main purpose of personal advising is to empower tenants with more effectiveness.
The **priority is to stress simple actions that can significantly reduce energy consumption**. The energy ambassadors are specially trained to insist on simple efforts that can help controlling energy costs and improving comfort and health. They hand out flyers with energy savings tips during their home visit and can provide any relavant advice.

A guide or a web site is helpful to support caretakers and social workers that act as climate ambassador. Such tool provides deeper information in energy consumption and savings in dwellings. Specific issues, such as air quality, can also be addressed in the guide.
Additional tools might also be distributed to energy ambassador in order to support the ESM dissemination. During the implementation of energy ambassador's projects, partners often noticed that energy helped in closing gaps between people and in networking.

TENANTS' EMPOWERMENT ASPECTS

TENANTS HANDBOOK

The Handbook differs from a simple communication campaign toward tenants. **In order to be energy-efficient, the message provided in the hadbook has to be customized for the tenants**. A too general message may have not the impact that is waited.
The objective is not only to raise the attention of the tenants regarding their energy impact but also to provide pragmatic information that will **help us to have a better use of their dwelling and to reduce their consumptions in order to save energy AND to reduce their energy fees**.
As a matter of fact, it is reminded that tenants handbook is both useful to raise the attention about global energy stakes and to be used a practical tool fort tenants to better understand the place they are living in and how to interact with it.

Hanbook holds a priority position in energy awareness araising. It is indeed an indispensable tool for energy efficiency dissemination.

ENERGY CAMPAIGNS

Tenant education campaigns are interesting in order to complete a Hanbook and to have more direct communication with the tenants.

The double advantage is that the message provided will have **a triple effect**:

- **Improving its impact thanks to a direct communication** and a humain exchange between the tenant and the person responsible for information supply.
- **Precising the communication regarding the tenants**, a direct communication will help to have time to adapt the discourse to the tenants' characteristics and to offer answers to questions.
- **The communication time is also a time to create social link** that will include the energy approach in a larger team building with the tenants as a responsible actor.

CARETAKERS TRAINING

The caretakers hold a priority position in energy awareness improvement.
As a proximity actor and partner he/she is fully aware of the characteristics for a building and offers a daily contact with the tenants. This link will help to create a better contact and a more direct approach with the tenants.
Caretaker is also the partner that knows better the daily activity of the building, who will be first in contact with the issues; its intervention can have a major impact.

TIPS AND ATTENTION POINTS

☑ ADAPT THE MESSAGE PROVIDED TO THE

TARGETED PUBLIC

The handbook or written information must be **created in order to communicate to concrete tenants and not to idealized and standard users**.
The social housing sector is attached with some particular tenants that will nee some special attention (migrants, elderly people, disabled people, people with reading issues).
A handbook conception must be attached with some **pedagogical efforts to adapt the content to the tenants**.

What are the levers able to make the tenants modify theirs behaviors?
The motivation has to play with some **values and norms** (cf. the Scientific Methodology part of the Annex I dedicated to the tenants awareness in order to have an overview for this topic).
It is sometimes an error to believe that **energy and sustainable consciousness** is the only message that will raise the awareness of the tenants.
Some **other levers** can be identify such as:

- **Money** and the potential reduction of the fees.
- **Health** of the family .
- **Well-being** and thermal comfort.
- **Social image of the tenants** and adaptation the social new norm (notion of «informational social influence» that is defined as the « *psychological phenomenon where people assume the actions of others in an attempt to reflect correct behavior for a given situation*».

Money and health for the family are often good messages to deliver a more complex information regarding energy.

A good handbook has to target **the 3 main different types of tenants**:

- Tenants already possessing an existing **eco-friendly behaviour or awareness** and that will only need small incentives and concrete explanations on how to use their dwelling the best way.
- Tenants with **neutral behaviours regarding energy topics** and that will need to be more involved in the energy savings of their dwellings with adapted, concrete and useful message.
- Tenants that are **the most reluctant to the energy-savings** and that are more in a individualistic and short-term approach of energy issues and that will need a more coercive educations or a message answering to their values).

As a consequence, **messages have to be plural**.
It may be **a good tip to involve the tenants in the conception of the handbooks** (meetings with a group of tenants or with the tenants association) in orer to adapt the message and to identify what are their expectatives.

☑ DELIVER CONCRETE AND SIMPLE INFORMATION

"Keep it simple" must be the motto of efficient Handbooks (even if it is not an easy thing with more and more complex equipments in the new buildings).
The information provided to the tenants must be clear and concrete. Information on the technical performance and functioning of the equipments and of the building will not help the tenants to improve their behaviors**. Information focusing on the uses and the services provided is essential** to involve the tenant and being close to its daily concerns.

Some attention points to enhance the impact of the Handbook must be mentioned:

•Choise **a clear and pleasant layout** (space, colors, etc.), energy questions have not to be treated with an austere design.
• **Use pictures to be more concrete** than written information, simple schemes, etc.
• Use **clear numbers**: for example, cost savings must simply presented with corresponding data to allow the tants to understand directly what is their interest.
• **Involve testimonies and tips from other tenants**.
• Play with **media and formats**: for example, Internet pages can offer a good opportunity to display information using short movies, TV connexions can be used to display messages, etc.

☑ SUPPORT WRITTEN FORMATS WITH SOCIAL EVENTS

The Hanbook is a fix document, nevertheless the moment of its dissemination is really important to ensure its success.

Do not hesitate to create a special event with the SHOs' team in order to deliver it to the tenants and create a collective emulation.

Some attention **reminders** can also be provided at some key moments: prepatory meetings during a refurbishment of for a new construction, maintenance visits by the SHOs technicians, refurbishment, with the delivering of the energy bill, etc.

☑ FOCUS ON FUTURE USERS

When asking to its tenants to have a long-term view on energy consumptions, a SHO must adopt the same bahavior focusing on the future. As a consequence, **children and young users are a very important public to target with the Handbook and energy information**.

Different Handbook can be provided with a simpler message, leaflets or stickers can be distributed with the original Handbook in order to target more specially children and to raise their awareness regarding energy since the early stage.

☑ MOBILIZE A LARGE PANEL OF PARTNERS AND KEEP IT LOCAL

In order to be efficient, SHOs have to sustain their energy campains using a diversity of partners that can all be able to participate to an awareness process.

Among the potential partners we can identify:

- **Tenants' associations** that can prepare a framework to involve the tenants in the energy campains helping to organize and to moderate meetings, trainings, etc. The idea is to have a link between the SHO and its tenants and to make the communication easier with a

spokeperson - which is supposed tto represent the interests of the tenants - o able to transmit and to «translate» the information
- **Outside partners such as institutions or associations specialized in the energy awaraness campains**. The triangulation with a third party and the intervention of partners having routines regarding energy education can have a very positive aspect on the communication with tenants.
- **Technical staffs** are essential to disseminate good practices among the tenants organizing training and helping the tenants to learn simple actions to save energy. Having a good knowledge of the buildings, their equipments and the main issues met they are a key element to strengthen and adapt the communication to the SHO's objectives.
cf ESM: caretaker training for more detail.

The local scale is often a field with a diversity of actors that can be involve regarding these awareness aspects. The objective is to present to the tenants some identifiable interlocutor sharing a same reality a to give a sensation of promixity relation.

☑ PREPARE FACE-TO-FACE CONTACT AND EDUCATIONAL TIME

The way the contact the user is important in order not to be perceived as intrusive. An awareness campaign has to be planned and announce to the tenants thanks to an appropriate pre-communication.

Face-to-face discussions are often more efficient regarding large and collective meetings that will be use to express other claims that the claims linked with the energy saving topic. **Face-to-face discussions strengthen a sense of attention and make easier a question/answer approach for complex topics**.
Face-to-face discussions are also a good space to imply concretely the tenants and to sstain him in its daily life showing how the equipments have to be used or delivering a direct diagnosis of what has to be changed observing its behaviors and habits.

☑ ENERGY IS A SHARED TOPIC FOR THE SHOs MANAGEMENT TEAMS

The interface constitued by the caretaker underline the necessity to think the energy topic accross the technical staff of the SHO and its rental management activities.
The energy topic is at a shared between the technical teams that will design and maintain the building and the rental management teams that will manage tenants and their uses of the building.
As a consequence, tenants education may be weakened by the fact that - being at the border between the attributions of two different parts of the SHO - nobody will take decisions and effective actions.

Both technical teams and rental management teams of the SHOs must to be involved in the same process. SHOs have to create common space and time to exchange about the energy stakes for a housing stock and to include since the beginning of the project the tenants' awareness topic (especially with low energy buildings that will need more involvement from the tenants).

Discussions have to be implemented by the SHOs regarding general tenant information. **Tasks need to be allocated between the two teams before the construction of the building**.
This discussion will empower the rental management service and will help them to have a better knowledge of the technical objectives for a building. This preparation will help the rental management services to create an adapted follow-up with the technical staff after the arrival of the tenants in the buildings.
It is also important to present the SHO staff as a gathered team and reassure that the energy questions will be treated commonly by the SHOs' service.

DETAILED ASSESSMENT
Values extracted from a x sample of dwellings
Values extracted from a x sample of dwellings

 **20 rue Géricault , 49 000 Angers, FRANCE**	**Number of dwellings** 20 **Number of floors** 3 **Heated surface** 862 **Inhabitants** 23	**Tenant handbook provided to every tenant including recommandations on ventilation of the dwellings and heating.**	**Investment & initial costs**	2500 EUR
			Energy costs for heating and DHW energy consumption	2008 : 12 113 EUR 2009 : 12 033 EUR 2010 : 12 477 EUR 2011 : 11 512 EUR 2012 : 13 574 EUR
	year of construction: 1972 **year of ESM implementation**: 2010		**Heating energy consumption and DHW energy consumption (N: normalized)**	2008 : 219 719 kWh **(N : 263 365 kWh)** 2009 : 221 640 kWh **(N : 264 769 kWh)** **Average :** **264 067 kWh** 2010 : 232 525 kWh **(N : 237 028 kWh)** 2011 : 220 772 kWh **(N : 331 426 kWh)** 2012 : 195 472 kWh **(N : 236 593 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : - 10% 2011 : + 25% 2012 : -10%
 **72, rue du 8 mai, 49130 Les-Ponts-de-Cé, France**	**Number of dwellings** 220 **Number of floors** Not relevant **Heated surface** Not relevant **Inhabitants** 532	**Implementation of a pilot dwelling (3 rooms-70 m2) with an association specialized in energy savings. The pilot dwelling has been visited by 220 persons in 6 months.** **The content of the visits is dedicated both to tenants and to caretakers of the building and the neighborhood. The visit includes :** - **training about the energy stakes in the dwelling.** - **Simple behaviors to have in the dwelling focusing on ventilation, heating. and electricty.** - **Understanding of the energy bill** **The team of the association will work with the SHOs staff and with the tenants in order to ensure a follow-up and an assessment. Another dwelling of the SHO has equiped in another neighborhood.**	**Investment & initial costs**	6810 EUR
			Energy costs for heating and DHW	Several buildings involved (no global data)
	year of construction: several dwellings involved (70's-80's) **year of ESM implementation**: **2011**		**Heating energy consumption**	Several buildings involved (no global data)
			% of energy reduction before/after the implementation of the ESM	Qualitative assessment: Approx. -11 EUR/month (83kWh) on the monthly invoice for heating for a sample dwelling : 70m2) Approx. – 2 EUR/month on the monthly invoice for Domestic Hot Water
	Number of dwellings 65 **Number of floors** 14 **Heated surface** 3497	**Control of the functionality of the thermostatic valves on the basis of complaint of tenants or in case of the planned control, exchange of TRVs in whole building.** **Education of tenants about correct use of**	**Investment & initial costs**	Price of one TRV is 33 EUR including installation hourly rate of energy officer is cca 11 EUR/hour

 **Mladi 25, Havirov, CZECH REPUBLIC**	**Inhabitants** 178	**TRVs in case of complaints of tenants on high consumption or insufficient temperature in apartment etc., personal visit of local caretaker in apartment explaining functionality of TRV.** **Within planned check of functionality, exchange of TRVs**		
	year of construction: 1983 **year of ESM implementation:** 2007		**Energy costs for heating and DHW**	2007: 25273 EUR 2008: 23118 EUR 2009: 24984 EUR 2010 : 28366 EUR
			Heating energy consumption (N: normalized)	2005-440 622 kWh **(N : 415 255 kWh)** 2006-423 137 kWh **(N : 431 421 kWh)** 2007-458 107 kWh **(N : 485 043 kWh)** **Average** : **443 906 kWh** 2008-381 173 kWh **(N : 416 250 kWh)** 2009- 377 676 kWh **(N : 409 773 kWh)** 2010- 454 610 kWh **(N : 412 716 kWh)**
			% of energy reduction before/after the implementation of the ESM	2008 : - 6% 2009 : - 8% 2010 : - 7%
BO GODT  **Dyvekevaenget, 2300 Copenhagen S, DENMARK**	**Number of dwellings** 140 **Number of floors** Not provided **Heated surface** 10 246 **Inhabitants** 412	**Climate Ambassadors: Educating tenants (women-network of non-danish background) in energy-friendly and environmental-friendly behavior.**	**Investment & initial costs**	250 EUR per tenant
			Normalized heating energy consumption	2005: 341 192 kWh 2007: 331 970kWh
	year of construction: 1996/1997 **year of ESM implementation:** 2006		**DHW consumption**	2005: 17.038 m3 2007: 15.371 m2
			% of energy reduction before/after the implementation of the ESM	Heating : - 3% Domestic Hot Water : - 10%
SPL www.spl.si  **Plešieva ulica 35,37,39,41 , Ljubljana, SLOVENIA**	**Number of dwellings** 88 **Number of floors** 6 **Heated surface** 4818 **Inhabitants** 185	**Subcontractor/ caretaker education. District heating maintenance manual for subcontractors /Training subcontractors to secure that the energysaving goals are reached**	**Investment & initial costs**	100 EUR per tenant
			Energy costs for heating	2008-36.000 EUR 2009-29.459 EUR, 2010-30.078 EUR 2011(1-11)-20.255 EUR
	year of construction: 1982 **year of ESM implementation:** 2009		**Heating energy consumption**	2008-640 870 kWh **(N : 556 022 kWh)** 2009-527 920 kWh **(N : 469 688 kWh)** 2010-585 920 kWh **(N : 473 781 kWh)**

				2011-411 240 kWh **(N : 360 709 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009 : -16% 2010 : -15% 2011 : -35%
 H2-College Birk Centerpark 77, 79, 81, 83 + 93, 7400 Herning. DENMARK.	**Number of dwellings** **66** **Number of floors** 1 **Heated surface** 2498 **Inhabitants** 66 to 100 **year of construction:** 2009 **year of ESM implementation**: 2009	**First Social Passive Housing building in Denmark (building located for maximum sunlight / double heatflow ventilation / heavily insulated / low energy windows / geothermal system with a heating pump) Tenant information about heating system and tips/motivation in written form are delivered. This awareness process is supplied by direct information from local staff.** **The target group for the building induces a special context: H20 college is a university housing unit, with students tenants mean frequent transfers, some period of vacancy in the dwellings and other characteristics regarding the use of the building and its equipment.**	**Investment & initial costs**	6.313.200 EUR
			Total energy consumption	2010 : 97 796 kWh **(N : 85 862 kWh)** 2011: 105 962 kWh **(N : 112 674 kWh)** cf. Pilot ESM HERNING for additional information for the years 2012 to 2014.

OPERATING MANAGEMENT

ESM: ELECTRIC LOAD SHEDDING

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Electric load shedding / Demand response

INITIAL ISSUE RELATED TO THE ESM
In electricity grids, demand/response mechanism has to be differentiate with dynamic mechanisms. Customer consumption of electricity may be managed in response to supply conditions. For example, electricity customers may be able to reduce their consumption at critical times or in response to market prices.

Demand/response mechanisms respond to explicit requests to shut off, whereas dynamic demand devices passively shut off when stress in the grid is sensed.
Demand response can involve curtailing power used or starting on site generation which may or may not be connected in parallel with the grid.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Current **demand response schemes are implemented with large and small commercial as well as residential customers**, often through the use of dedicated control systems **to shed loads in response to a request by a utility or market price conditions.**

Under conditions of tight electricity supply, **demand response can significantly decrease the peak price and, in general, electricity price volatility**.
Demand response is generally used to refer to mechanisms used to encourage consumers to reduce demand, thereby reducing the peak demand for electricity.
Since electrical generation and transmission systems are generally sized to correspond to peak demand (plus margin for forecasting error and unforeseen events), lowering peak demand reduces overall plant and capital cost requirements.

A load shedding is a technical device that will allow a reduction of the electrical power subscrided. It interrupts for a moment the power supply of the electrical heaters in some cases when the overall power consumption is superior to the electrical power subscribed.
This device helps to optimize the electrical consumption.

They are **different types of load shedding systems**:

«**domino**»: shedding of the circuit 1, then - if there is still an unbalancing between subscrided supply power and the power consumption, the shedding of the circuit n°2 will be actived, then the shedding for the circuit n°3.

- **cyclical**: the shedding will be active thanks to a rotary system without hierarchy between the several affected circuits.

- **combined**: gathering the 2 modes with a cyclical system applied during a first time and then a domino system activated if the first solution is not efficient enough.

The dissemination for this device is of course limited as many SHOs do not electricity in their housing stock for heating and as this system is more adapted for individual dwellings.

TENANTS' EMPOWERMENT AND COMFORT ASPECTS

Electrical load-shedding do not represent major risks of discomfort for the tenants as the time for shedding is very short and will not have particular impact on the indoor temperature and the thermal comfort of the tenants.
Furthermore, this device will allow to significantly reduce the subscription costs for electricity as the subscrided supply power will be reduced.

This aspect is both interesting at a local level - the bill will be less important - and at a national level - as it will reduce the national electricity consumption.

TIPS AND ATTENTION POINTS

☑ BE CAREFUL IN CHOSING THE CIRCUITS FOR SHEDDING

The **concept of priority** is really important in order to guarantee a good comfort for the use of this device.
The **most sollicitated equipments will not have to be put in the prioritary circuit for shedding** as an interruption may lead to discomfort and to unexpected results.

☑ CONNECT THE LOAD SHEDDING DEVICE TO THE ELECTRICITY METER

This choice will allow not to add one metering system for the intensity on every equipment included in the load shedding circuit.

☑ CHOSE LOAD SHEDDING DEVICES THAT WILL INTEGRATE THE ELECTRICITY HOURLY RATE

A special attention can be carried out on the peak time regarding some domestic appliances in order to optimize the electrical consumption on their electric outlets.

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

 **12, 14, 16, 18, 20, 22, 24 ; 28, 30, 32 rue du Haut Chêne, Angers FRANCE**	**Number of dwellings** 20 **Number of floors** 4 **Heated surface** 862 **Inhabitants** 23 **year of construction:** 1996/1997 **year of ESM implementation:** 2006	**Regular electric load-sheddings managed by a subcontractor**	**Investment & initial costs/flat** **Reduction of energy costs for electricity** **Amount of electric reduction before/after the implementation of the ESM**	711, 89 EUR cca 50 EUR /dwelling/year cca 570 kWh/dwelling/year

OPERATING MANAGEMENT

ESM: PROFIT-SHARING CONTRACTS

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Performance contracting

INITIAL ISSUE RELATED TO THE ESM
Regular maintenance keeps energy systems in good operating state order. It allows keeping them running at an optimal efficiency level.
Therefore, maintenance downgrading and low-efficiency is one of the main risks faced concerning energy efficiency. Even for well-written contracts, a slow reduction in the implementation of the quality for the maintenance routines might be noticed.
Regular contract review is necessary in order to keep a maintenance program efficient, to update and to adapt the contract content and to empower the staff of the service provider.
Contract review aims at ensuring that the maintenance action plan is performed to achieve the best energy performance target.

Maintenance subcontractors signing a performance contract with profit-sharing system have a stronger incentive to increase the energy efficiency of heating systems.
Pure service EPC is a business model where the subcontractor is committed to deliver the benefits of maintenance to a specified level of performance and reliability. Therefore, pure service contracting helps reducing energy consumption immediately without requiring any investment.
It appears particularly interesting for SHO that may in later stage improve efficiency with investment.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Maintenance downgrading is an important risk of energy wasting as continuous reduction in maintenance quality leads to decrease energy efficiency of buildings.
Over time, regular maintenance benefits might indeed end up if contract review is not carried out.

A maintenance contract can include:

• **Technical decisions**:
- Modification in the breakdown between preventive and corrective actions,
- Maintenance schedule,
- Control boiler startup and stop planning,
- Intervention process (delay, tools...),
- Energy efficiency target,

• **Economical decisions,**
- Cost,

• **Legal decisions**:
- Incentives,
- Insurance,

• **Management decisions**:
- Meeting schedule between SHO and subcontractor,
- Key performance indicators,

The objective is **to improve the framework and distribution for contractual commitments between the SHOs an its supplier** regarding the energy supplying, the maintenance of the system and the replacement of its par. SHO has to guarantee that the heating system is operating accurately, and that the heating degrees required contractually are provided. Energy efficiency objectives must well be defined.

The EPC's methodology differs from traditional contracting as it is performance-oriented.
The ESCO is paid according to rules depending on its results, and linked with its ability to ensure a quality of performance. In the profit sharing model, ESCO and SHO share the energy bill savings resulting from the EPC project. **The percentage allocated to each stakeholder is defined in the contract and depends wether ESCO has supported itself any energy efficiency investment or not**. If so, ESCO receives a greater part of savings in order to reimburse its equipment expenditure and services. Otherweise, savings are generally equally shared.

In the pure service EPC model, energy performance results from service improvement and incentives based on a profit sharing basis and of a continuous improvement of the operation service.
This contract allows correct operation of the installation and correct adjustment of combustion efficiency and outputs.
The energy supply contractor is not always concerned with energy supply, the cleaning, balancing and control of equipement is really a factor of better output of the installation and better energy efficiency. The advantage remains in tenants and ESCOs having both interests in carrying out energy saving because they share the benefits.

A baseline is set in the contract and is adjusted according to the climate reality. The indoor temperature and the heating period are also set. The profit sharing provision allocates the gap between a baseline and a real comsumption and split it between SHO and ESCO.
The dissemination of a profit sharing requires a good knowledge of prior consumption and metering, especially if hot water is produced with the boiler.

MAINTENANCE ASPECTS

The contractor is responsible for the running of energy system, including in particular:

• The **starting and stopping date for the heating system running period**;
• The **settings and adjustments of temperature for water in the**

heating circuit during the heating season;
• The commissioning of equipment.

Maintenance is mainly preventive, but may also include **corrective actions such as**:

• **Maintenance of backflow preventers**;
• **Sludge removal**;
• **Cleaning and balancing of hydraulic system**;
• **Heating water treatment**;
• **Cleanliness of a burner**, cleaning, monitoring and adjusting the combustion head;
• **Control of pipes, valves, filters and air bleeds**;
• **Measurement of various operating parameters of equipment to optimize performance** and meet the standards of air emissions;
• **Replacement of defective light sources**.

MANAGEMENT ASPECTS

Contract review is a part of the quality assurance process**. Even if maintenance is outsourced, it is important that SHO continue to be involved in energy management** and contribute to make contract evolve. It is, indeed, the responsibility of SHO to keep a high level of requirement and hold a continuous watch on maintenance optimisation.
A contract has to be considered as an evolving tool that can be renegotiated by the SHO in order to adapt the work of its supplier to its need and its objectives in terms of energy performance.

A consultancy study may be useful in order to have a better overview of the practices included in the contract and to better anlyze them in terms of energy performance and costs. This complementary study can help the SHO in modyfying the contract in order to improve its efficiency and its relevancy adapted to the structure of the company.

Discussions between SHO and contractor should cover:

• The **baseline and the service level agreement**;
• The **maintenance plan**;
• The **costs**;
• The **tenant awareness** management;
• The **rules for sharing the savings**;
• The **lower and upper limit of sharing** if relevant;
• The **plan for measuring and verification of consumption**;
• The **billing** of fixed costs of energy expenditure (subscriptions, etc.);
• The contract ending;

TENANTS' EMPOWERMENT ASPECTS

The **contract for heating isn't a very known tool for the tenants**. Even if the contract review has to be considered as an ESM really «internal» to the **SHO its effects will impact the tenants and their energy bills**.

The **transparency** regarding the contract, the need to explain the issues met during the heating season and the corrections that have been implemented in order to overcome them directly involve the tenants.
The responsibility of the SHO is to provide a certain level of heating to the tenants; it is a management choice to determine how the process for providing this degree is done. Nevertheless some targeted information can improve the relationships of the SHO with its tenants. It is particularly recommended for a SHO to play with open cards and transparency regarding a profit-sharing contract providing to the tenants elements to explain their bill or to explain the incidents.

Energy performance contracting may **require a special monitoring concerning the indoor temperatures** provided in the dwellings in order to verify if the subcontractor meets its contractual commitment.
It is also recognized that energy performance contracting implementation needs a well-prepared information campaign to avoid problems with tenants. **For transparency reasons, the methodology used for profit-sharing calculation has to be comprehensive for all stakeholders, including tenants**.

TIPS AND ATTENTION POINTS

☑ INCLUDE AND CONTROL AN INCENTIVE CLAUSE

An incencitive contract allows a SHO to obtain more control on its provider regarding the provision of service.

The objective **is to guarantee a certain level of performance for the heating system (this performance can be estimated through a certain amount of heating degrees provided by the system to a building) thanks to a system of penalties/compensations**.

The contract is defined as an incencitive contract as the service provider directly encourages performing good and efficient maintenance operations. The control on the heating system is controled using a range of security clauses concerning its payment and with some financial sanctions.
The **mechanism of the incentive contract is quite simple and can be adapted**.
If the energy provider has good performance and that the quantity of heating provided is inferior to be has been modelized in the contract, a financial contribution will be shared through the energy provider and the SHO (with a certain percentage of distribution).
If the performance is negative, energy provider will receive penalities and the losings will be partly financed on its retribution.»

☑ WORK ON THE DELIVERED TEMPERATURES

A **more precise study on the delivered temperatures** can be implemented in a contract review.
The objective is to reduce energy consumptions for the system without affecting the comfort of the tenants.

This work on the temperatures delivered to the tenants can cover very different intentions:

- A very **short overestimation of the temperature delivered to the tenants** in order to fit with their comfort habits without having a gap between the expected performance and the real consumption

resulting from the tenants' uses.
- The **implementation of a night reduction of the temperature delivered in the dwelling (approx. 3°C)** in order to save energy when the uses of the tenants do not require more heating.
- A **postponed starting time for the heating system in certain high performance buildings that will require less heating during the mid season** thanks to the performance of their insulation.

☑ INCLUDE A PLANNING FOR POTENTIAL ENERGY SAVING MEASURES

As mentioned in the first part of the Factsheet, a contract has to evolve and to adapt to the operating conditions of the SHO. It may be interesting in a maintenance contract to plan and modelize (costs, potential savings, etc.) some energy saving measures that may be implemented on the housing stock of a SHO.

This process settles **a list of optional modelized investments** that could be implemented by the SHO on its housing stock in order to save energy.
This approach will help the SHO to have **a better mid-term and long-term overview on the energy management of its housing stock** with both a control on the costs and the energy savings. It is a very efficient planning and decision-making tool at a large-scale, very useful to implement an energy-saving strategy in a contract.

☑ USE THE CENTRALIZED TECHNICAL MANAGEMENT SOLUTIONS TO KEEP AN EYE ON THE PROVIDERS WORK

The effectiveness and the realism of the controls implemented by the service provider on the heating system regarding maintenance is a major element to assess the quality for its service.
Implementation of temperature sensors can be useful to check the efficiency with an overview of the temperatures delivered in the dwellings.
This battery of measures will complete the assessment tools used by the service provider (observation of the heating system, return temperature of the heating water) with more qualitative data on the real performance for heating in the building.
The objective is to obtain a «toolbox» of parameters aimed at controling the performance of the maintenance in order to reach an optimal level of intervention and to be able to reacton-time to any deviations regarding the expected objective.

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

 **30, 32, 34, 36, 38 square des Capucins, Angers, FRANCE**	**Number of dwellings** 40 **Number of floors** **Heated surface** 2654 **Inhabitants** 105	**Contract review aimed at decreasing the operation costs of central heating &nd hot water heating installations.** **In a building with central heating condensation boiler (power 814 KW) and radiators ; individual natural gas instantaneous water-heating** **Implementation of the energy supply and operation contract with an energy saving objective.** **Operation, running maintenance, heating water treatment, sludge removal, quarterly indoors temperature recordings, balancing ; improvement with energy-saving equipments ; 1/3 of energy costs, compared to theorical needs (within limit of 15 %), allocated to the ESCO.** **+ quarterly energy and operation expenses reportings**	**Investment & initial cost /flat**	572, 73 EUR (ingeneering consultation)
			Energy costs for heating	2008: 18 287 EUR 2009: 18 765 EUR 2010: 18 071 EUR 2011: 18 668 EUR 2012: 18 604 EUR
	year of construction: 1963 **year of implementation of the ESM**: 2009		**Heating energy consumption**	2008: 403 185 kWh (N : 483 275 kWh) 2009: 411 253 kWh (N : 491 279 kWh) 2010: 401 623 kWh (N : 409 400 kWh) 2011: 268 492 kWh (N : 403 064 kWh) 2012: 332 990 kWh (N : 403 042 kWh)
 8 groups of buildings. i.e : Les Viviers II (32) - 24, 26, 28, 30, 32, boulevard Millot - 49100 Angers	**Number of dwellings** 68 **Number of floors** **Heated surface** 4584 **Inhabitants** 168	**Contract review aimed at decreasing the operation costs of central heating &nd hot water heating installations.** **In a building with central heating condensation boiler (power 814 KW) and radiators ; individual natural gas instantaneous water-heating** **Implementation of the energy supply and operation contract with an energy saving objective.** **Operation, running maintenance, heating water treatment, sludge removal, quarterly indoors temperature recordings, balancing ; improvement with energy-saving equipments ; 1/3 of energy costs, compared to theorical needs (within limit of 15 %), allocated to the ESCO.** **+ quarterly energy and operation expenses reportings**	**Investment & initial costs/flat**	572, 73 EUR (ingeneering consultation)
	year of construction: 1964 **year of implementation of the ESM**: 2009		**Energy costs for heating**	2008: 31 107 EUR 2009: 37 793 EUR 2010: 38 810 EUR 2011: 39 860 EUR 2012: 36 071 EUR
			Heating energy consumption	2008: 604 404 kWh (N : 724 465 kWh) 2009: 640 385 kWh (N : 684 746 kWh) 2010: 694 063 kWh (N : 707 504 kWh) 2011: 753 380 kWh (N : 1 1130 984 kWh) 2012: 602 999 kWh (N : 729 853 kWh)

30, 32, 34, 36, 38 square des Capucins, Angers, FRANCE			**% of energy reduction before/after the implementation of the ESM**	2009 : -+2% 2010 : -15% 2011 : -17% 2012 : -17%
8 groups of buildings. i.e : Les Viviers II (32) - 24, 26, 28, 30, 32, boulevard Millot - 49100 Angers			**% of energy reduction before/after the implementation of the ESM**	2009 : -6% 2010 : -2% 2011 : +56% 2012 : -1%

OPERATING MANAGEMENT

ESM: BMS SOLUTION

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Building energy management

INITIAL ISSUE RELATED TO THE ESM
The purpose of this ESM is to reduce the consumption of heating energy by installing a control devices and technological solutions to adapt the supply temperature of the heating system.
Some of the new heating systems include a so called Building Management System (BMS) aimed at following and controlling the running time and settings of the system. BMS system helps to monitor and to regulate certain of its parameters (such the temperatures within the heating system, air flow rates within the ventilation system, return temperature and flow temperature in the heating systems, etc.).
BMS are efficient in order to improve the efficiency of a system. In order to be performant, they have to be adapted to these systems and to be regulated correctly.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Installation of a control monitoring tool for the heating system. **The solution is coupled with an outdoor temperature sensor to adapt the heat production to the heat needs in dwellings**. The result is that the flow temperature is reduced and the pipe heat loss lowered.
The **controller uses radio technology to communicate with temperature sensors, data collector and heat cost allocators**. Via remote access, the operation control center (solution provider) ensures the system operates properly and efficiently.

The BMS makes easier the current management and optimization of the systems.
To resume, this technology combines several components that will all have an impact on the management and the regulation of a system. **The objective is to reach an automatized system thanks to a smart software that will settle a communication network between several points of the system**.
Thanks to the sensors and the associated metering points, information will be transmitted automaticcaly to a data collection and treatment unit.

This data (which can include several parameters such as water temperatures within the heating system, outdoor or indoor temperatures, humidity, etc.) will help to have a complete overview on the current performance and state of the heating system and to identify its efficiency and adjust its settings directly or thanks to some technical interventions.

MAINTENANCE AND MANAGEMENT ASPECTS

Thanks to these systems it will be **possible to optimize the regulation of the system on-time and be more reactive regarding the alerts thanks to a better and actualized data collection**.

The knowledge of the buildings developed thanks to the data collection will also allow to strengthen and develop remote management for the system thanks to automatized interventions.

TENANTS' EMPOWERMENT ASPECTS

The solution can provide **regular reports to customers** to inform them about the energy savings achieve in their buildings.

The BMS will also allow to strenghten the relationship with the tenant providing more data and for better understanding of individual situation in a building (identification of the different water temperatures in the different parts of a system, indoor temperatures and humidity in the dwellings, etc.).

This precision can refine the technical interventions and help to better understand the individual situation and to provide an appropriate answer.

Regarding a complete description for this system it is recommand to read the report dedicated to Pilot Energy Saving Measure RIESI developed within the AFTER project by the Social Housing Housing Organization ATC in Turin.
ATC has been using for the purpose of the AFTER project a particular Building Management System named ADAPTERM© and provided by the German company TECHEM.

TIPS AND ATTENTION POINTS

☑ PREFER FLEXIBLE BMS

BMS have to be adapted to the uses and realities of a SHO.

The objective is to obtain a well-used and defined system that will be efficient for the SHO and its technical staff.
In order to guarantee it, the SHO has to define its needs for such a system. Relevant questions may be interrogate the mass of data useful for the SHO to collect, the scale of its housing that need to be impacted by the project. There is also a requirement regarding the distribution of the responsibilities for the management of the BMS information between energy providers and the SHO technical staff (who will have to analyze the data, etc.).
This task is really important in order not to overcharge the SHOs team through a flow of new information. The collected amount of figures needs to be easy to manage, analyse and red by the SHO.

The monitoring of the BMS is an important stake as it will require some special skills and mobilize some staff to analyze the data and find a good compromise about the interventions with its energy provider or maintenance supplier.
Engineering consultants will be useful to define these needs and find the adapted answers.

☑ JUSTIFY FINANCIALS HELPS

BMS systems is also an useful tool to justify and to help quantitfying the results supposed to validate some of the requirement for the European subsidies on energy performance (FEDER funds) or the local/national subsidies.
As a consequence, investing in those types of systems may be a good opportunity to allow SHOs to better evidence and argument their efforts and performance in terms of energy savings.

DETAILED ASSESSMENT
Values extracted from a x sample of dwellings

bauverein AG darmstadt  **Schiebelhuthweg 19-25, Darmstadt, GERMANY**	**Number of dwellings** 40 **Number of floors** 4 **Heated surface** 2530 **Inhabitants** App. 100	**Monitoring of the heating system:** **Installation of the "Adapterm module" to control and adapt the supply temperature of the heating system.** **Adapterm is an intelligent energy-saving system for all houses already equipped with or to be equipped with Techem's radio heat cost allocators. Simply coupled to the heating control unit (independent of whether you heat using oil, gas or district heating), it adapts the heat production of your heating system to the actual heat requirements in your building. Adapterm thus lowers energy consumption and costs at the same time lastingly.**	**Investment & initial costs/flat**	1 100 EUR
	year of construction: 1960 **year of ESM implementation:** 2010		**Energy consumption for heating and DHW** **(N : normalized)**	2008 : 255 895 kWh **(N : 245 538 kWh)** 2009 : 245 343 kWh **(N : 241 936 kWh)** **Average :** **243 737 kWh** 2010 : 218 249 kWh **(N : 185 988 kWh)** 2011 : 274 395 kWh **(N : 295 704 kWh)** 2012 : 238 628 kWh **(N : 229 062 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : - 24% 2011 : + 21% 2012 : - 6%
bauverein AG darmstadt  **Kaupstraße 30, Darmstadt, GERMANY**	**Number of dwellings** 8 **Number of floors** 4 **Heated surface** 574 **Inhabitants** App. 30	**Monitoring of the heating system:** **Installation of the "Adapterm module" to control and adapt the supply temperature of the heating system.** **Adapterm is an intelligent energy-saving system for all houses already equipped with or to be equipped with Techem's radio heat cost allocators. Simply coupled to the heating control unit (independent of whether you heat using oil, gas or district heating), it adapts the heat production of your heating system to the actual heat requirements in your building. Adapterm thus lowers energy consumption and**	**Investment & initial costs/flat**	1100 EUR

	1980 **year of ESM implementation**: 2010	**costs at the same time lastingly.**	**Energy consumption for heating and DHW** **(N : normalized)**	2008 : 120 796 kWh **(N : 115 907 kWh)** 2009 : 105 950 kWh **(N : 104 479 kWh)** **Average :** **110 193 kWh** 2010 : 106 018 kWh **(N : 90 347 kWh)** 2011 : 57 819 kWh **(N : 62 309 kWh)** 2012 : 69 244 kWh **(N : 66 468 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -18% 2011 : -43% 2012 : -40%
 **Via Riesi 5, Orbassano, TURIN**	**Number of dwellings** 51 **Number of floors** 10 **Heated surface** 1807 **Inhabitants** 145 **year of construction:** 1995 **year of ESM implementation**: 2010	**Monitoring of the heating system: Installation of the "Adapterm module" to control and adapt the supply temperature of the heating system.** **Adapterm is an intelligent energy-saving system for all houses already equipped with or to be equipped with Techem's radio heat cost allocators. Simply coupled to the heating control unit (independent of whether you heat using oil, gas or district heating), it adapts the heat production of your heating system to the actual heat requirements in your building. Adapterm thus lowers energy consumption and costs at the same time lastingly.**	**Investment & initial costs**	94.050,00 EUR
			Energy costs for heating and Domestic Hot Water	2008: 69.170,64 EUR 2009:70.550,60 EUR 2010: 80.052,72 EUR 2011: 82.066,11 EUR
			Energy consumption for heating and Domestic Hot Water	2008 : 516.950 kWh **(N : 516 811 kWh)** 2009 : 482.610 kWh **(N : 440 850 kWh)** **Average :** **478 830 kWh** 2010 : 437.790 kWh **(N : 395 354 kWh)** 2011 : 420.050 kWh **(N : 412 407 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : - 17% 2011 : - 14%
	**Number of dwellings** 51 **Number of floors** 4 **Heated surface** 1844 **Inhabitants** 143	**Monitoring of the heating system: Installation of the "Adapterm module" to control and adapt the supply temperature of the heating system.** **Adapterm is an intelligent energy-saving system for all houses already equipped with or to be equipped with Techem's radio heat cost allocators. Simply coupled to the heating control unit (independent of**	**Investment & initial costs**	103 050 EUR

Via Calvino 31, Orbassano, TURIN	**year of construction:** 1995 **year of ESM implementation**: 2010	**whether you heat using oil, gas or district heating), it adapts the heat production of your heating system to the actual heat requirements in your building. Adapterm thus lowers energy consumption and costs at the same time lastingly.**	**Energy costs for heating + lighting**	2008: 53.187,5 EUR 2009: 52.252 EUR 2010: 70.466,7 EUR 2011: 69.397,82 EUR
			Energy consumption for heating and Domestic Hot Water	2008 : 472.130 kWh **(N : 472 003 kWh)** 2009 : 503.830 kWh **(N : 460 233 kWh)** **Average :** **466 118 kWh** 2010 : 381.880 kWh **(N : 344 863 kWh)** 2011 : 407.940 kWh **(N : 400 517 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : - 27% 2011 : - 14%

OPERATING MANAGEMENT

ESM: ENERGY MONITORING FOR TENANTS

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Energy monitoring/Web tools

INITIAL ISSUE RELATED TO THE ESM
Building characteristics have a significant effect on energy consumptions. The energy used in a building is, morevover, strongly corelated to the behaviour of its occupants. Recent studies indicated that in already highly efficient buildings, the behaviour of occupants has an increasing role in consumption.

The energy comsumption is depending on the behaviour of its occupants: how people use, maintain equipments, how they choose the level of inside temperature, etc.
Recent feedbacks underline the importance of providing to the tenants relevant information for an effective energy management. Energy monitoring for tenants is -then- an interesting solution to inform, and to empower tenants. This technological support is suitable to provide information in order to reduce both energy and water consumptions or improve comfort and indoor environnemental quality of the dwelling.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

The aim is **to provide to the tenant a suitable energy monitoring**. This energy monitoring supported by an information system improve the energy management for a dwelling or a building.
The information about energy consumptions and costs is often communicated thanks to bills to the tenants. The objective of energy monitoring aims at **refining this information to make it more understandable, precise and instantaneous**. Measuring and communicating live the consumptions for every dwelling is a new way to improve this energy monitoring.

Heat cost allocators are a general solution about the way to individualize the consumptions ; energy monitoring is providing tools to communicate and display this information to the relevant stakeholder.
When heat cost allocators imply a strategy regarding the administration of the energy consumption, the energy monitoring solutions involve solutions about its communication.
This ESM is part of the new approach of energy savings supported by innovative smart metering systems and information technology systems. These systems target an improvement of the management of the heating and hot water consumptions.

The first step for such approach is **to implement suitable building monitoring system, including technical devices to ensure the monitoring of the data**. This system may include sensors for signal acquisition, elements for the transmission and the analysis of the information, etc.
The measured parameters may include water and energy consumptions and comfort parameters such as internal temperatures or relative humidity.

A **digital interface dedicated to the users** has to be developed allowing the tenant to visualize the energy monitoring results.
This user interface can be proposed through a website. **In order to avoid the necessity to have an internet acces, the use of the TV screen for example can also be considered**.
As an attention point, **the developped user interface has to be user friendly, readable and fastly understable**.
Through this ESM the tenant is supposed to get both suitable and relevant informations through a dedicated dashboard. Some specific services can be proposed through this dedicated interface : advices on best energy saving practices, bills loading, etc.

MAINTENANCE ASPECTS

Maintenance related to measurements units (sensors, ...).

TENANTS' EMPOWERMENT ASPECTS

Energy monitoring for the tenants is a good example of how technology can be used not only as a mysterious too box but as an empowerment tool and as a lever to make the personal behaviors evolve.
The energy monitoring is **an interesting additional tool for the tenants as it gives a material incentive to raise the attention and a «signal» of the consumption**. It is also useful to have a more long-viewed overview on its own energy consumptions and to have a comparison line with a standard that will help to regulate its individual behaviour.

Energy monitoring straigthly provides support to the tenants on energy saving topics. Providing a metering regarding the consumptions, the energy monitoring is very useful **expanding the energy information** to the tenants and **offering quantified details and content adapted to the individual behaviors**.
It offers them an opportunity to have a better overview of the way they consume energy, to be more involved and better control their energy consumptions. However, **the impact of this ESM is drastically connected to the tenant's empowerment process** and their interest. In order to reach significant energy consuptions cuts, the tenant has to consider as very important the energy saving at home and to understand that their own actions can significanty influence their energy consumption.
The energy monitoring will certainly help to convince him, but it required as a preliminary step that the tenant be enough open-minded and curious to "give a chance" to the proposed interface.

TIPS AND ATTENTION POINTS

☑ COMPLETE THE SMART METERING SYSTEM WITH SOME QUALITATIVE HELP

The energy monitoring is **a good tool to improve the awareness of the tenants** and **to impulse a better knowledge** of the uses, behaviors, habits. It is also a leading process concerning the impacts of the awareness campaigns implemented by the SHOs.
The energy monitoring gives sense of responsibility and understanding for the tenants. Nevertheless, in order to be efficient, **such technologies need to be integrated in the globality of ESMs and tools developed in WP3**.

Energy monitoring is a tool and not a final purpose. It has to be completed with adequate message provided to the tenants. Written materials an face-to-face contact is a major advantage to refine the understanding of the objectives for energy monitoring, not to create unrealistic expectations, to ensure that the material will be weel-used by the tenants and to propose concrete actions to have an impact on the monitoring.
The energy monitoring system have to be inserted in a larger educational strategy.

☑ TAKE A SPECIAL ATTENTION TO THE ERGONOMICS OF THE SYSTEMS

The energy monitoring systems destinated to the tenants have **to be adapted to daily habits of the tenants and to their availability**. Incentive is better than constraint, and - as a consequence - the **readibility** of the energy monitoring has to be specially designed.

Some elements can improve this design:

- the **delivering of concrete information accompanied with the corresponding quantitative/qualitative translation**: kWh of consumed energy is useful, but this information can be gathered with a quantity of the savings, a translation in terms of economic costs (essential), concrete translation of the savings in terms of sustainability, etc.
- the **formats have to be diversifed**: Internet portal are a good prospective tool but SHOs must not forgive that Internet is not yet a current habits for the tenants.
Some solutions can added to the Internet tool such has the use of the **television** to deliver the energy information about consumptions an the corresponding «tips».
SMS and cell phones are also a new tool very displayed accross the tenants and may be a good support. Written information (by letter for example) will still be useful as the media have to be diversified to be efficient et as some tenants are still mainly focused on the lecture.
- a **clear information with simple medium**.
Curves or graphics can sometimes be hard to understand to read for the tenants (or at least they will relevant to identify an evolution nut not for a level of consumption). **More adapted signals** are often more efficient: **notation systems** to assess the level of consumption, **alarms**, **codes** with red/orange/green lights corresponding to level of consumptions or too hogh/low temperatures, etc.
Information collected thanks to the sensors have to be disseminated efficiently in order to justify the investment and to create a link between the technical interface and the actions of the tenants.

☑ COMPARE WITHOUT BALKING

The **comparison is a important aspect of the energy monitoring** as it will:

- **help the tenants both to identify their own consumptions regarding a norm** and a trend.
- **create a sense of collective belonging** and mobilization (having impacts on the global life of a bulding).
- develop an **emulation and competition** in order to reach the same level of performance (or maybe to get better performances).

The objective aims at guaranteing a good presentation of these results and patterns to the tenants.
It can be included on an Internet portal with a comparison between the tenants consumptions and the best ones (or expected results) or in hallway entrances.

WARNING: it seems important to make **a difference between comparing and blaming**. The objective is not to «demonize» tenants with moral disapproval and to expose a lack of privacy. The objective is to create collective involvement and to disseminate best practices highlighting good examples and show some potential for improvement that can be reached by everybody.

☑ ADAPT THE ENERGY MONITORING IN LOW ENERGY BUILDINGS (MARGIN FOR IMPROVEMENT OF THE INFORMATION).

Low energy buildings will **change the distribution of energy consumptions in these buildings** with a larger importance for the electric consumptions for domestic hot water, ventilation and for electic domestic appliances (cf. ESM Factsheets for WP7).
The weight of every one of these consumptions in the global performance for the building will be very important.
As a consequence, the energy monitoring may be aapted in these buildings with more precise regarding the abitration between all the different consumptions .Energy monitoring will be interesting to redefined in these buildings with a better overview on what is consuming energy and at what moment (in particularly in order to show to the tenants potential savings to reach regarding domestic appliances, etc.).

DETAILED ASSESSMENT
Values extracted from a x sample of dwellings

 **Le Haut Chêne (160) - 12, 14, 16, 18, 20, 22, 24 ; 28, 30, 32 rue du Haut Chêne, Angers, FRANCE**	**Number of dwellings** 100 **Number of floors** **Heated surface** 7072 **Inhabitants** 216 **year of construction:** 1985 **year of ESM implementation:** 2009	**Online monitored hot, cold and central heating water metering for tenants with website access and maintenance fee.**	**Investment & initial costs**	Implementation of the monitoring system: 202, 30 EUR/dwelling. Maintenance of the monitoring system and rent: 26, 8 EUR/dwelling. Website: 3 EUR/dwelling/year
			Energy consumption for heating	2008: 498 151 kWh **(N : 597 105 kWh)** 2009: 410 953 kWh **(N : 490 921 kWh)** 2010: 497 657 kWh **(N : 507 294 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009 : -18% 2010 : -15%
 **J. Jaburkove 1,3,5. Havirov, CZECH REPUBLIC**	**Number of dwellings** 36 **Number of floors** 4 **Heated surface** 1759 **Inhabitants** 73 **year of construction:** 1962 **year of ESM implementation:** 2005	**Web portal created to increase the awareness and the involvement of the tenants regarding the management and the visualisation of their water and heating energy consumptions.** **Internet portal: www.merenitepla.cz** **Wireless radio frequency meters of heating energy (RF thermometers), hot, cold water consumption are installed in apartments.** **Consumption data are transmitted via gateway to an application server where they are stored and processed. This system allows the remote reading of heating energy and hot and cold water consumptions in individual apartments and the visualisation of consumption data to tenants on internet user web portal in graphical and numerical form.Consumption is visualised on the web portal in real time after each reading, several times per day (hourly reading). The website also provides outputs of comparison with previous period's consumption (for the individual apartment) and with the other apartment's consumptions (anonymously).**	**Investment & initial costs**	6 388 EUR
			Energy costs for heating	2006: 14 447 EUR 2007: 15 003 EUR 2008: 16 021 EUR 2009: 16 138 EUR 2010: 14 723 EUR
			Heating Consumption	2003: 304 480 kWh **(N : 295 475 kWh)** 2004: 293 929 kWh **(N : 284 375 kWh)** **Average :** **289 925 kWh** 2005: 281 600 kWh **(N : 265 388 kWh)** 2006: 256 960 kWh **(N : 261 991 kWh)** 2007: 268 280 kWh **(N : 284 055 kWh)** 2008: 271 040 kWh **(N : 295 982 kWh)** 2009: 248 160 kWh **(N : 269 250 kWh)** 2010: 232 320 kWh

				(N : 210 911 kWh) **Average :** **264 596 kWh**
			% of energy reduction before/after the implementation of the ESM	Between baseline and monitoring period : - 9%

WP4: RUNNING MAINTENANCE

This work package is specifically dedicated to ESM related to the running maintenance of the central heating and ventilation systems managed by the SHO.

The running maintenance ESM are most of the time subcontracted to heating providers and Facility Management companies. It deals usually with low cost measures like the balance and the regulation of the heating systems, the insulation and the cleaning of the hot water pipes, the maintenance of the boilers and the substations. These low cost measures have usually a short return on investments and are highly profitable.

The WP4 have three fields of investigation.

1. To assess the recent maintenance systems. During the last decade, a lot of investments have been done in the replacement of heating systems (e.g. generalisation of the boilers with condensation). The replacements were coupled with new ICT on line maintenance systems. The project AFTER will pay a particular attention to the most recent monitoring systems in order to assess if they contribute to a more preventive approach of the running maintenance reporting more precisely the failures of an equipment (e.g. a valve, a decreasing quality of the regulation, etc.). The project AFTER will assess the energy savings gained with a just-in-time maintenance.
2. To compare the performance of the recent equipments (with the last 5 years) and their economic performance (kwh/m² saved per year per Euro invested) in order to prioritize the interventions of the running maintenance.
3. The prevention of the misuse of the ventilation systems by the tenants. Due to an increase of the energy prices, the tenants' tend to seal the vents (e.g. the vents in the window frames) is increasing in parallel. It creates a lot of problems (e.g. moistures) and impacts the energy performance of buildings. It becomes an important problem to identify equipments which can't be sealed by the tenants and have the capacities to ensure a permanent quality of ventilation.

RUNNING MAINTENANCE

ESM: HYDRAULIC BALANCING

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Hydraulic balancing of heating system.

INITIAL ISSUE RELATED TO THE ESM
The purpose of this ESM is to reduce the consumption of heating energy by balancing the hydraulic controller to adapt the supply temperature of the heating system. This procedure is highly important to achieve a proper distribution of the heat inside a building.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

By hydraulic balancing the heating system of a building tenants will obtain a proper heating flow inside their houses no matter how far they are from the source point. This ESM has a very cost-effective result since it is a maintenance issue but, for the same reason, only a poor maintenance would increase the heating energy used. It is not a matter of saving energy but a matter of not wasting it.

Establishing a hydraulic balance in a system often is a matter of controlling the differential pressure to a level necessary for operating the substation and thereby also controlling the flow rate in individual branches. Controlling differential pressure and flow rate in the system can have advantages for customers and utilities. This will in the future bring hydraulic balance in district heating systems into focus in the continuous effort to reduce the operating costs.
A district heating network is in hydraulic balance when the water flow to the individual consumers is exactly what they need to fulfil the demand for heating in the house. According to the specification, hydraulic balance means limitation of the flow range in a system to a flow rate corresponding to real consumption.

Only a hydraulically balanced system ensures a proper feeling of comfort and a normal cost for the central heating. The procedure is clearly of vital importance and is therefore necessary. The larger the hot water heating system is, the more important it's hydraulic balancing. The project's documentation must define elements needed, their settings, required measurements and the resulting costs.

The required technical know-how and equipment are now available, so there are no objective reasons to neglect hydraulic balancing.

The negative consequences of neglect of hydraulic balancing are as a rule proportional to a building's size and take different forms:
- Non-uniform heating through a building's height and length. The more distant a room, the more evident the problem.
- Central regulation of the system is difficult because the heat flow is not distributed properly.
- A circulation pump which would otherwise be adequate is insufficient, so it is replaced with a more powerful one.
- The risk of noise in the part of installation closest to the circulation pump.
- Uneconomic operation of the system due to the more powerful circulation pump and overheating of part of a building.

MAINTENANCE AND MANAGEMENT ASPECTS

In order to achieve an efficient distribution of the heat inside a building, it is highly important to repeat this procedure at least every year. A good period to perform the hydraulic balance of the heating system could be in autum before the cold weather arrives.

TENANTS' EMPOWERMENT ASPECTS

Cf. Tips

TIPS AND ATTENTION POINTS

☑ IMPLEMENT AN EFFICIENT ROUTINE TO CONTINUE IMPROVING THE SYSTEM

For the implementation of the correct hydraulic balancing the most important thing is quality project documentation. In the project documentation there are determined regulation elements to be installed and their setting (flow rates and pressures) calculated by special programme owned by the project designer.

The work process includes these steps:

1) Mapping of the real situation of the heating system by the project designer in the building.

   Mapping of the type of radiators; dimensions of pipelines from connecting point to radiators.

2) The values found out in the building are entered in the programme that creates the project documentation. The project designer determines regulators and valves that will be installed and the settings of individual regulation elements.

3) Development of the project of the hydraulic balancing.

4) Purchase of the material by housing organisation in accordance with the project. Purchase regulation elements from one company in order to have in all housing stock the same regulation elements and to simplify the process.

☑ GATHER DOCUMENT IN AN EFFICIENT WAY

Even if the heating system in a building was hydraulically balanced in the past, the energy consumption figures can indicate some complementary potential for further energy savings.
This can be derived from high temperatures of the returning water which means that the heating system is not operated efficiently.

- The heating system is noisy.
- After 15 years of operation some components, especially TRVs can be replaced.
- Some parts of the heating system do not heat properly.
- The heating system is not hydraulically completely well balanced.

It is recommended to replace all old TRV valves and to install new combined flow and differential pressure regulators.
By using specialized service adjust new flow settings on TRVs. It is suggested to tune the heating curves and use optimised temperature gradient in the future if possible.
The goal is to define the optimized flow characteristics and optimized values of supply water temperature and return water temperature. Each radiator shall receive specific amount of hot water defined by the service provider calculation.

☑ TARGET THE TENANT AFTER AN HYDRAULIC BALANCING

After complete balancing of the system, a simple manual could be given to each tenant (including new entrants) recalling the principles of operation of the equipment, the ambient temperature and the impact recommended additional billing degree.
The tenant is informed, for example, to avoid putting his/her washing towels every day, or not to open the windows when there is heating (ie lower the thermostat if it is too hot).

☑ CONTROL THE THERMOSTATOC VALVES

In order to control and to prevent the tenants misuses, the thermostatic valves can be controlled.
The thermostat may not be blocked, but tenants can think they can adjust the temperature to their liking, but with a maximum temperature is limited to 24 ° C (control point at the boiler outlet).

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

 **Mládí 25, Havirov, CZECH REPUBLIC**	**Number of dwellings** 66 **Number of floors** 14 **Heated surface** 3498 **Inhabitants** 172 **year of construction:** 1983 **year of implementation of the ESM:** 2007	**Regulation of pressure: From 243 valves it has been exchanged 149 type of head 99-RK, valve VE4262H, in the basement manual regulation valve STAF DN80, differential pressure regulator DA516 in size DN80 including installation.** **+ additional maintenance : radiators bleeding, repair of TRVs, repair of leakages on radiators, replacement of radiators.**	**Investment & initial costs**	11458 EUR
			Energy costs for heating	2007 – 25 273 EUR 2008 – 23 118 EUR 2009 – 24 984 EUR 2010 – 28 366 EUR
			Heating energy consumption	2006: 423 258 kWh **(N : 431 646 kWh)** 2007: 458 238 kWh **(N : 485 182 kWh)** 2008 :381 282 kWh **(N : 416 386 kWh)** 2009: 374 286 kWh **(N : 406 094 kWh)** 2010: 451 242 kWh **(N : 409 658 kWh)**
			% of energy reduction before/after the implementation of the ESM	2007 : +12% 2008 : - 4% 2009 : - 6% 2010 : -5%
 **Uzavrená 2,4,6, Havirov, CZECH REPUBLIC**	**Number of dwellings** 36 **Number of floors** **Heated surface** 1780 **Inhabitants** 72 **year of construction:** 1962 **year of implementation of the ESM:** 2010	**Hydraulic balancing of the heating system and installation of the thermostatic valves :** **New regulation and closing valve type Kombi-2-Plus on vertical pipelines no. 19-27.** **Closing valve type Kombi have been installed on the other vertical pipelines on supplied pipes.** **Differential pressure regulator type Kombi-Auto V5001P has been installed on return pipe of all vertical pipelines.** **Regulation valve Honeywell, Kombi-2-Plus, in connecting point.** **New Heimeier TRVs (V-exakt, typ II).**	**Investment & initial costs**	11 862 EUR
			Heating energy consumption	2007: 315 331 kWh **(N : 333 872 kWh** 2008 : 344 847 kWh **(N : 376 580 kWh)** 2009: 322 964 kWh **(N : 350 411 kWh)** **Average :** **353 621 kWh** 2010: 367 307 kWh **(N : 333 458 kWh)**

				2011 : 333 780 kWh **(N : 365 333 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -6% 2011 : +3%
SPEKTER poslovanje z nepremičninami **Trg revolucije 16, Trbovlje, SLOVENIA**	**Number of dwellings** 52 **Number of floors** 14 **Heated surface** 2970 **Inhabitants** 102	**Connecting valves were built-in on return flow line. Balancing valves Danfoss ASV-PV (adjustable differential pressure regulators) and Danfoss ASV-I (adjustable shutter valves and metering valves) were installed. In all apartments radiator valves were switched for new Danfoss thermostatic valves with additional fine regulation. At the end complete system was balanced and regulated with newly installed valves.**	**Investment & initial costs**	12 000 EUR
			Energy costs for heating (NB: Monthly heating consumption data multiplied with ESCO's current pricelist (EUR/MWh) at that time. The calculated numbers don't include annual cost of standing charge and annualized connection charge.)	2008 : 6957,24 2009 : 13125,35 1st half 2010 - 7437,06 2nd half 2010 - 5601,97 1st half 2011 - 8250,58
	year of construction: 1970 **year of implementation of the ESM**: 2010		**Heating energy consumption**	2007 : 270 400 kWh **(N : 232 928 kWh)** 2008 : 251 900 kWh **(N : 346 483 kWh)** 2009 : 224 900 kWh **(N : 206 624 kWh)** **Average :** **219 776 kWh)** 2010: 236 500 kWh **(N : 191 980 kWh)** 2011: 212 800 kWh **(N : 193 736 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : - 13% 2011 : - 12%
LE TOIT ANGEVIN Groupe Podeliha	**Number of dwellings** 85 **Number of floors** 6 **Heated surface** 4596 **Inhabitants** 121	**Installation of valves on all heating columns**	**Investment & initial costs**	76066,35 EUR
			Energy costs for heating (	2008 : 25 260 EUR 2009 : 31 276 EUR 2010 – 32 021 EUR 2011- 29 947 EUR 2012 : 29 114 EUR
	year of construction:			

 **57 & 59 rue du Maréchal Juin** **49 000 Angers, FRANCE**	1969 **year of implementation of the ESM**: 2010		**Heating energy consumption**	2008 : 323 704 kWh **(N : 388 006 kWh)** 2009 : 267 062 kWh **(N : 319 030 kWh)** **Average :** **353 518 kWh** 2010: 323 404 kWh **(N : 329 667 kWh)** 2011: 158 700 kWh **(N : 238 242 kWh)** 2012: 272 127 kWh **(N : 328 164 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -7% 2011 : -32% 2012 : - 7%

RUNNING MAINTENANCE

ESM: REGULATION DISTRICT HEATING

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Change of regulation in district heating system

INITIAL ISSUE RELATED TO THE ESM
The purpose of this ESM is to reduce the consumption of heating energy by improving the regulation system in the heating system.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

District heating systems can play an important role in increasing the use of Renewable Energy Sources (RES) for heating purposes, but also in reducing total primary energy demand. Due to economies of scale, the district heating systems provide an opportunity of using deep geothermal heat as well as unrefined biomass (e.g. waste wood, straw, forestry residues) and municipal solid waste. The district heating systems also enable the utilisation of surplus heat in industries (industrial waste heat) and thermal power plants via combined heat and power production, thus reducing primary energy demand.
District heating is a relatively matured industry compared to e.g. telecommunications and therefore substantial innovations occur less frequently. The sector is also benefiting from innovations brought about from other industries such as improved communication, controls and regulation.
Ultimately, most of the implemented innovative solutions are aimed at improving energy efficiency of the district heating system even though they may be generated by very different approaches.
Company management has always been supportive of introduction of innovative ideas wherever those were economically justified or brought about improved comfort or safety to the customers or company employees. Some examples are:

• Real time regulation of district heating system. A software tool enables real-time modelling of the district heating system and predicting development of its status based on outside temperature and taking into account factors such as heat accumulation in the system and centrally managed change of the heat supply to different areas by means of remote access into control systems of the heat exchanger stations. The result is optimal distribution of total load among different plants connected to the system which brings about substantial economic as well as environmental savings.

• Remote monitoring and control of heat exchange stations. Enables operators to automatically monitor and set parameters of heating in heat exchange stations which improves efficiency as well as reliability of the system operation and reduces response time when dealing with disruptions of malfunction of the equipment.
• Remote reading of heat meters by means of data transfer and centralized processing brings about cost savings as well as improved accuracy of invoices while improving customers comfort.

MAINTENANCE AND MANAGEMENT ASPECTS

Although it is a very efficient way to reduce the consumption of energy, it is essential to keep a proper level of regular maintenance in a heating system, both in boilers and in the rest of the system. In order to achieve an efficient distribution of the heat inside a building, it is highly important to repeat this procedure at least every year. A good period to perform the hydraulic balance of the heating system could be in autum before the cold weather arrives.

TIPS AND ATTENTION POINTS

Same tips than for hydraulic balancing.

☑ IMPLEMENT COMPLEMENTARY INSULATION

Think to complementary insulation of the system for example insulating the heat exchanger for the district heating substation with some insulation can in order to reduce the thermal loses in the system.

DETAILED ASSESSMENT
Values extracted from a x sample of dwellings

SPEKTER poslovanje z nepremičninami  Trg revolucije 1, Trbovlje, SLOVENIA	**Number of dwellings** 14 **Number of floors** 5 **Heated surface** 1051 **Inhabitants** 29	**Change of regulation in district heating station :** **analog regulator was changed with digital regulator and district heating station was connected to remote control**	**Investment & initial costs**	5000 EUR
	year of construction: 1951 **year of implementation of the ESM**: 2009		**Energy costs for heating** (NB: Monthly heating consumption data multiplied with ESCO's current pricelist (EUR/MWh) at that time. The calculated numbers don't include annual cost of standing charge and annualized connection charge.)	2006 : 5059,64 EUR 2007 : 5007,35 EUR 2008 : 7253,75 EUR 1st half 2009 : 4709,76 EUR 2nd half 2009 :1779,19 EUR 2010 : 6563,91 EUR 1st half 2011 : 4180,52 EUR
			Heating energy consumption	2008 : 118 920 kWh **(N : 110 506 kWh)** 2009 : 111 700 kWh **(N : 102 623 kWh)** 2010: 118 680 **(N : 96 339 kWh)** 1st half 2011: 129300 kWh
			% of energy reduction before/after the implementation of the ESM	2009 : -7% 2010 : - 13%
SPL  Polje cesta V/1,2,3,4,5,7,9, Ljubljana, SLOVENIA	**Number of dwellings** 140 **Number of floors** 6 **Heated surface** 7825 **Inhabitants** 325	**Change of regulation in common heating station.**	**Investment & initial costs**	3200 EUR
	year of construction: 1996 **year of implementation of the ESM**: 2010		**Energy costs for heating**	2008: 81 812 EUR 2009: 74 082 EUR 2010: 85 802 EUR 2011: 105 764 EUR
			Heating energy consumption	2009:1 325 790 kWh **(N : 1 179 549 kWh)** 2010:1 249 220 kWh **(N : 1 010 131 kWh)** 2011:1 198 090 kWh **(N : 1 050 875 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -11% 2011 : -15%

RUNNING MAINTENANCE

ESM: CIRCULATING PUMPS

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Replacement of circulating pumps

INITIAL ISSUE RELATED TO THE ESM
The purpose of this ESM is to reduce the consumption of heating energy by replacing an old circulating pump for an intelligent one to adapt the supply temperature of the heating system.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

A circulator pump is a specific type of pump used to circulate gases, liquids, or slurries in a closed circuit. They are commonly found circulating water in a hydronic heating or cooling system. Because they only circulate liquid within a closed circuit, they only need to overcome the friction of a piping system (as opposed to lifting a fluid from a point of lower potential energy to a point of higher potential energy).
In the past circulating pumps operated continuously 24 hours a day or utilized a timer to schedule operating times around anticipated hot water demand periods. In a residential environment where occupant's lifestyles are anything but routine, using a 24-hour timer to schedule circulator pump operations would not be practical.
Growing environmental concerns call for greener eco-friendly products capable of satisfying consumers with different lifestyles.
Adapting intelligent circulating pump control to an existing system instantly adds greener control capabilities like; cycle on and off based on a temperature set point (fixed/adjustable) or time-of-day or day-of-week or push-button on-demand or occupancy sensor or sound sensor and more. Minimizing circulator pump operations saves valuable resources and the environment.

Replacing existing circulating pumps for intelligent ones will reduce tenants' heating consumption, making them able to perform a more accurate program fitted to tenants' lifestyles.
However, in many cases a more powerful circulating pump does not mean a better performance of the system. It is important to match the circulating pump with the needs of the tenants.

MAINTENANCE AND MANAGEMENT ASPECTS

It is a maintenance issue to keep track of the condition of the pumps, as well as the rest of components which form the heating system.
It is important to take note of the increased heat in the piping system, which in turn increases system pressure. Piping which is sensitive to the water condition (i.e., copper, and soft water) will be adversely effected by the continual flow. Although water is conserved, the parasitic heat loss through the piping will be greater as a result of the increased heat passing through it.
Small- to medium-sized circulator pumps are usually supported entirely by the pipe flanges that join them to the rest of the hydronic plumbing. Large pumps are usually pad-mounted.
Pumps that are used solely for closed hydronic systems can be made with cast iron components as the water in the loop will either become de-oxygenated or be treated with chemicals to inhibit corrosion. But pumps that have a steady stream of oxygenated, potable water flowing through them must be made of more expensive materials such as bronze.

TIPS AND ATTENTION POINTS

☑ IMPLEMENT GOOD SETTINGS FOR THE CIRCULATION PUMP

An underdimensioned or overdimensioned circulation pump can provock some deviations regarding the energy performance for a building.
For example if a first pump is not powerful enough, the water in the system will not be flowing fast enough Areas of the building may be poorly heated A more powerful pump need to be installed.
If a heating pump is set to its maximum power it can lead to an overconsumption for the pump.

Procedure for adjusting a variable flow pump:

o Memo: assume that static balancing of the system is achieved.
o Ensure that all terminal control valves are open. After receiving the system, the easiest way is to cause the lowering of the temperature of the dwellings for a day by cutting heating (prevent tenants in advance). Attention point: an efficient building takes a long time to cool. Count ten hours in cold weather in order to see the temperature drops significantly.
o Start from the smallest value, and increase the pressure set to achieve desired flow, usinga heat meter to measure the flow, or a balancing valve equiped with a pressure tap.
o Replace the terminal control and adjust the appropriate settings on the thermostats.

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

bauverein AG darmstadt Anton-Bruckner-Straße 10-12, Dieburg, Germany	**Number of dwellings** 24 **Number of floors** 3 **Heated surface** 1158 **Inhabitants** 50 **year of construction:** 1973 **year of implementation of the ESM**: 2009	**Exchange of the heating circulating pumps including mixers and sliders.**	**Investment & initial costs**	12 600 EUR
			Energy costs for heating	Before 14 847 EUR After 15 279 EUR
			Heating energy consumption	2008 : 189 544 kWh **(N : 181 872 kWh)** 2009 : 180 796 kWh **(N : 178 285 kWh)** 2010 : 215 479 kWh **(N : 183 628 kWh)** 2011 : 157 486 kWh **(N : 169 716 kWh)** 2012 : 209 682 kWh **(N : 201 276 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009 : -2% 2010 : +1% 2011 : - 7%
SPL Povšetova 14,16,18 , Ljubljana, SLOVENIA	**Number of dwellings** 68 **Number of floors** 6 **Heated surface** 3569 **Inhabitants** 130 **year of construction:** 1967 **year of implementation of the ESM**: 2010	**Replacement of a circulating pump in heating station**	**Investment & initial costs**	2065 EUR
			Energy costs for heating	2008: 18 750 EUR, 2009: 21 568 EUR 2010: 25 628 EUR 2011: 24 620 EUR
			Heating energy consumption	2008: 491 774 kWh **(N : 426 666 kWh)** 2009: 498 659 kWh **(N : 443 654 kWh)** **Average : 435160 kWh** 2010: 525 047 kWh **(N : 424 558 kWh)** 2011: 477 947 kWh **(N : 419 219 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -2% 2011 : 4%

RUNNING MAINTENANCE

ESM: REPLACEMENT OF BURNER

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY

Replacement of the burner for the natural gas in the heating system.

INITIAL ISSUE RELATED TO THE ESM

The purpose of this ESM is to reduce the consumption of heating energy by replacing a burner for the natural gas in the heating system which is inefficient, unoperable or unsafe. This inefficiency can be considered when the burner has a combustion efficiency of 72% or less after an inspection has been performed.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Oil fired heating equipment such as hydronic (hot water) boilers, steam boilers, warm air furnaces, and water heaters, have used heating oil, usually No. 2 heating oil, and various types of oil burners to burn the fuel, thus providing a heat source for nearly 100 years. A scheme of a conventional oil burner shown below, where we list the major parts of a modern oil burner.

Most oil furnaces perform best when running at their steady-state condition, with the maximum stable flue gas temperature. But the burner must run for as much as 20 minutes to reach this point, and some oversized units may never run long enough to get there, even on the coldest days.

Ideally, the oil furnace or boiler would run continuously when the outside temperature is at the lowest temperature expected for an area, or what is called the "design temperature." At that point, the furnace would be operating close to the steady-state efficiency for which it was rated. A lengthy running time at a local coldest design temperature is a practical goal. An oil heating system can be downsized simply by replacing the existing oil burner nozzle with a smaller one.

A competent onsite inspection of the entire heating system and chimney, performed by an expert usually finds additional clues that help accurately diagnose a problem or might make clear if upgrading the oil burner on the heating system makes sense. Some things to consider are:

Before considering a new oil burner, it's better to make a thorough inspection of boiler or furnace to be sure it's in good enough condition to be worth the investment. For example, if the heater is badly rusted or cracked, it needs to be replaced. If the heater itself is in good condition, the replacement burner can improve its efficiency and help to save money.

By improving the efficiency of the burner, it will need less fuel to achieve the same amount of heat since no fuel would be lost. At the same time, tenants' consumption will be lower since the flow of heat will be constant and proportional to the wasted fuel.

MAINTENANCE AND MANAGEMENT ASPECTS

It is a maintenance issue to keep track of the condition of the burners, as well as the rest of components which form the heating system.

TIPS AND ATTENTION POINTS

☑ IDENTIFY CORRECTLY THE POTENTIAL FOR RISK

A temperature too high smoke is indicative of poor water exchange fumes.
A defect of air causes a significant production of carbon monoxide (CO), fouling of the boiler and the flue because of the emission of unburned solids.
Setting a burner is one of the basic boiler maintenance actions to perform at least once a year.
Take out a maintenance contract to maintain optimal system operation.

☑ SECURE YOUR DECISION TO CHANGE THE BOILER

Replacing a burner must only be undertaken on relatively recent boilers (boiler and burner replacement in other cases).
Ensure –of course- the compatibility of the new burner with the current boiler.
Burner selection is made according to the needs of the building (2-

stage burner, modulating) and compared with the power of the existing boiler.

The installation of a new burner is carried out taking care to get a perfect tightness at the burner-unit link (connecting plates).

The adjustment shall be made on a cleaned boiler because the cleanliness of the exchange surfaces has a great influence on the flue gas temperature.
The measurement of combustion is only significant when the temperature of the boiler water level is close to its setpoint. The burner works with his or her case presented rigorously cover in place.

☑ IMPLEMENT A GOOD MAINTENANCE PLAN

Take out a maintenance contract to maintain optimal system operation. The air flow observation is particularly important.

A lack of air causes the formation of unburned solid particles, soot and tar depending on the fuel.

Excess air reduces the production performance.

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

bauverein AG darmstadt Albert Lortz-Straße 3-7, Dieburg, Germany	**Number of dwellings** 20 **Number of floors** 4 **Heated surface** 1660 **Inhabitants** 60	**New torch for the natural gas heating system**	**Investment & initial costs**	3148 EUR
	year of construction: 1968 **year of implementation of the ESM**: 2008		**Energy costs for heating**	Before 24 286 EUR After 31 914 EUR
			Heating energy consumption	2007 : 334 730 kWh **(N : 351 574 kWh)** 2008 : 351 351 kWh **(N : 337 130 kWh)** 2009 : 335 007 kWh **(N : 330 355 kWh)** 2010 : 396 158 kWh **(N : 337 600 kWh)** 2011 : 363 236 kWh **(N : 391 444 kWh)**
			% of energy reduction before/after the implementation of the ESM	2008 : -4% 2009 : - 6% 2010 : - 4%

RUNNING MAINTENANCE

ESM: INSULATION OF THE HEATING PIPES

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Thermal insulation of heating pipes in the unheated common areas.

INITIAL ISSUE RELATED TO THE ESM
The purpose of this ESM is to reduce the consumption of heating energy by insulating existing heating pipes in the unheated common areas of the buildings, such as maintenance rooms, staircases, hallways…

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

There are many applications and improvements that can be achieved by simply insulating heating pipes:

CONDENSATION CONTROL
Where pipes operate at below-ambient temperatures, the potential exists for water vapour to condense on the pipe surface. Moisture is known to contribute towards many different types of corrosion, so preventing the formation of condensation on pipework is usually considered important.
Pipe insulation can prevent condensation forming, as the surface temperature of the insulation will vary from the surface temperature of the pipe. Condensation will not occur, provided that (a) the insulation surface is above the dewpoint temperature of the air; and (b) the insulation incorporates some form of water-vapour barrier or retarder that prevents water vapour from passing through the insulation to form on the pipe surface.

PIPE FREEZING
Since some water pipes are located either outside or in unheated areas where the ambient temperature may occasionally drop below the freezing point of water, any water in the pipework may potentially freeze. When water freezes, it expands due to negative thermal expansion, and this expansion can cause failure of a pipe system in any one of a number of ways.
Pipe insulation cannot prevent the freezing of standing water in pipework, but it can increase the time required for freezing to occur—thereby reducing the risk of the water in the pipes freezing. For this reason, it is recommended to insulate pipework at risk of freezing, and local water-supply regulations may require pipe insulation be applied to pipework to reduce the risk of pipe freezing.[1]
For a given length, a smaller-bore pipe holds a smaller volume of water than a larger-bore pipe, and therefore water in a smaller-bore pipe will freeze more easily (and more quickly) than water in a larger-bore pipe (presuming equivalent environments). Since smaller-bore pipes present a greater risk of freezing, insulation is typically used in combination with alternative methods of freeze prevention (e.g., modulating trace heating cable, or ensuring a consistent flow of water through the pipe).

ENERGY SAVING
Since pipework can operate at temperatures far removed from the ambient temperature, and the rate of heat flow from a pipe is related to the temperature differential between the pipe and the surrounding ambient air, heat flow from pipework can be considerable. In many situations, this heat flow is undesirable. The application of thermal pipe insulation introduces thermal resistance and reduces the heat flow.
Thicknesses of thermal pipe insulation used for saving energy vary, but as a general rule, pipes operating at more-extreme temperatures exhibit a greater heat flow and larger thicknesses are applied due to the greater potential savings.
The location of pipework also influences the selection of insulation thickness. For instance, in some circumstances, heating pipework within a well-insulated building might not require insulation, as the heat that's «lost» (i.e., the heat that flows from the pipe to the surrounding air) may be considered "useful" for heating the building, as such «lost» heat would be effectively trapped by the structural insulation anyway. Conversely, such pipework may be insulated to prevent overheating or unnecessary cooling in the rooms through which it passes.

PROTECTION AGAINST EXTREME TEMPERATURES
Where pipework is operating at extremely high or low temperatures, the potential exists for injury to occur should any person come into physical contact with the pipe surface. The threshold for human pain varies, but several international standards set recommended touch temperature limits.
Since the surface temperature of insulation varies from the temperature of the pipe surface, typically such that the insulation surface has a «less extreme» temperature, pipe insulation can be used to bring surface touch temperatures into a safe range.

MATERIALS

Pipe insulation materials come in a large variety of forms, but most materials fall into one of the following categories.

Mineral wool
Mineral wools, including rock and slag wools, are inorganic strands of mineral fibre bonded together using organic binders. Mineral wools are capable of operating at high temperatures and exhibit good fire performance ratings when tested.[4]
Mineral wools are used on all types of pipework, particularly industrial pipework operating at higher temperatures.

Glass wool
Glass wool is a high-temperature fibrous insulation material, similar to mineral wool, where inorganic strands of glass fibre are bound together using a binder.
As with other forms of mineral wool, glass-wool insulation can be used for thermal and acoustic applications.

Flexible elastomeric foams
These are flexible, closed-cell, rubber foams based on NBR or EPDM rubber. Flexible elastomeric foams exhibit such a high resistance to the passage of water vapour that they do not generally require additional water-vapour barriers. Such high vapour resistance, combined with the high surface emissivity of rubber, allows flexible elastomeric foams to prevent surface condensation formation with comparatively small thicknesses.
As a result, flexible elastomeric foams are widely used on refrigeration and air-conditioning pipework. Flexible elastomeric foams are also used on heating and hot-water systems.

Rigid foam
Pipe insulation made from rigid Phenolic, PIR, or PUR foam insulation is common in some countries. Rigid-foam insulation has minimal acoustic performance but can exhibit low thermal-conductivity values of 0.021 W/(m·K) or lower, allowing energy-saving legislation to be met whilst using reduced insulation thicknesses.

Polyethylene
Polyethylene is a semi-flexible plastic foamed insulation that is widely used to prevent freezing of domestic water supply pipes and to reduce heat loss from domestic heating pipes.
The fire performance of Polyethylene usually prohibits its use in commercial buildings.

Cellular Glass
100% Glass manufactured primarily from sand, limestone & soda ash.

Aerogel
Silica Aerogel insulation has the lowest thermal conductivity of any commercially produced insulation. Although no manufacturer currently manufactures Aerogel pipe sections, it is possible to wrap Aerogel blanket around pipework, allowing it to function as pipe insulation.
The usage of Aerogel for pipe insulation is currently limited.
With a proper insulated system in a building, tenants will obtain a proper flow of heat inside their houses no matter how far they are from the source point. This ESM has a very cost-effective result since it is a maintenance issue but, for the same reason, only a poor maintenance would increase the heating energy used. It is not a matter of saving energy but a matter of not wasting it.

MAINTENANCE AND MANAGEMENT ASPECTS

It is a maintenance issue to keep track of the condition of the burners, as well as the rest of components which form the heating system.

TIPS AND ATTENTION POINTS

☑ BE EFFICIENT REGARDING THE POSITIONING OF THE WATER PIPES NETWORK

The implementation of the heating pipes network is a very important attention point. It will influence the performance for the building and will prevent potential deviations regarding the thermal loses.
The netork need to be implemented in the heated volume of the building in order to avoid the circulating water and the emission of heating being lost by the contact with a fresh air.
The tightness for these water pipes has to be well implemented : the drilling of the pipe need to be implemented with precision (using acrylic joints for example).
The crossing of the pipes network need to be particularly well prepared when meeting walls.

The network need to be well implemented in order not to provocke heat loses when implemented outdoor but preventing also overheating of some spaces in the dwelling.

☑ GUARANTEE THE QUALITY OF THE INSULATION FOR THE WATER PIPES

An incomplete insulation on the return line of for the chilled water supply can cause condensation.
Concerning hot water pipes, this incomplete insulation can cause a loss of efficiency of the system and energy consumption.
For this reason it is important to implement a particular survey in order to insulate the pipe portions untreated.
It is also important to check during the design phase that the gap between the pipes, or between the pipes and the walls, will allow to implement correctly the insulation of the pipes with the relevant material. Ths dimensiong has to be an attention point during the conception of the network.

☑ CHOSE AN ADAPTED INSULATION MATERIAL

The insulation of the pipes can be done using several types of materials: mineral fibers, rubbers, polyurethane foams, polyethylene.
Regarding the choice of the insulation material, the SHO will have to take care of the relationship between the insulation chosen and the system: the use of mineral wool will require a special protection (plastered coated cloth). PVC layers or alumium, the use of rubber is more appropriated to the small diameters of pipes.

DETAILED ASSESSMENT
Values extracted from a x sample of dwellings

Lavričeva ulica 15, **Ljubljana, SLOVENIA**	**Number of dwellings** 12 **Number of floors** 3 **Heated surface** 547 **Inhabitants** 24 **year of construction:** 1925 **year of implementation of the ESM**: 2010	**Thermal insulation of heating pipes in the unheated common areas**	**Investment & initial costs**	134 EUR
			Energy costs for heating (NB: Monthly heating consumption data multiplied with ESCO's current pricelist (EUR/MWh) at that time. The calculated numbers don't include annual cost of standing charge and annualized connection charge.)	2008:3088 EUR 2009:3417 EUR 2010:4022 EUR 2011:3522 EUR
			Heating energy consumption	2008: 85 200 kWh **(N : 73 929 kWh)** 2009: 84 190 kWh **(N : 74 903 kWh)** **Average :** **74 416 kWh** 2010: 82 500 kWh **(N : 66 710 kWh)** 2011: 68 630 kWh **(N : 61 074 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : - 10% 2011 : - 18%

RUNNING MAINTENANCE

ESM: CLEANING OF BOILER

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY

Thermal insulation of heating pipes in the unheated common areas.

INITIAL ISSUE RELATED TO THE ESM

The purpose of this ESM is to reduce the consumption of heating energy by insulating existing heating pipes in the unheated common areas of the buildings, such as maintenance rooms, staircases, hallways...

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

By cleaning boilers of a heating system in a building tenants will obtain a proper heating flow inside their houses no matter how far they are from the source point. This ESM has a very cost-effective result since it is a maintenance issue but, for the same reason, only a poor maintenance would increase the heating energy used. It is not a matter of saving energy but a matter of not wasting it.

2.2. Maintenance aspects (if relevant)
Although it is a very efficient way to reduce the consumption of energy, it is essential to keep a proper level of regular maintenance in a heating system, both in boilers and in the rest of the system. In order to achieve an efficient distribution of the heat inside a building, it is highly important to repeat this procedure at least twice every year. A good period to perform a general inspection of the heating system could be in autum before the cold weather arrives and after the cold season.
These are some of the most important flaws that can be prevented with maintenance:

• Cold spots.
Cold spots are among the most common faults in central heating systems. If caught in time, they are straightforward to fix. However, they can cause considerable damage to the system if left untreated. Cold spots at the top of a radiator are caused by air entering the system or hydrogen gas forming as a result of corrosion. Radiators in this state require frequent venting.
When cold spots occur in the middle and lower parts of a radiator, they stem from a build-up of magnetite (iron oxide), which appears as a black sludge. This forms as a result of electrolytic corrosion (a chemical reaction between metals). Cold spots that occur throughout the system may be the result of bacterial contamination.

• Aeration
Aeration of circulating water leads to rapid corrosion. In almost all untreated central heating systems hydrogen gas is produced because of corrosion. However, gas should not be confused with air. Using any Fernox Protector F1 prevents corrosion and the formation of both hydrogen and bacterial gases such as methane. Aeration can take place at the same time as gas formation, but this fault cannot be corrected by corrosion prevention alone.

• Limescale deposition.
The mineral deposits, collectively known as limescale, consist primarily of calcium and magnesium carbonates which are generally insoluble. Limescale occurs when these are deposited by heating water that contains soluble bicarbonate salts (which are thermally unstable and break down to form carbonates).
Minerals in chalk or limestone rock collect as water permeates through the ground and collects in aquifers. These minerals remain within the water and are carried into the domestic water supply. They inevitably reach central heating and water systems, where they build up over time and cause blockages in pipework, efficiency losses and the premature failure of components. These problems can arise in both the primary water system (the central heating system) and secondary (household hot water) system.

There are several factors that contribute to the build-up of limescale, including:

-High (temporary) hardness
-Elevated pH (alkalinity) of the water
-Elevated temperature

Corrosion.
Corrosion occurs when a refined metal reverts back to its natural ore state. Corrosion in water systems takes place when two areas of metal with a different electrical charge are in contact or linked via a conductor such as water.

A boiler creates steam by applying heat to water and sending the resulting vapor through pipes to a radiator. The purpose of cleaning and flushing is to protect against mineral oil contamination, particularly in low temperature hot water central heating systems by removing harmful flux residues and installation debris, which cause corrosion. This routine maintenance strategy will keep residues from interfering with the plumbing that provides heat.
It is also neccesary to clean systems and removes black sludge (iron oxide) and limescale which improves circulation and reduces fuel wastage and boiler noise. Ideally the system should be powerflushed to remove any existing treatment and contaminant. A cleaner should be added to system water and circulated hot for at least one hour. After which the system must be drained and flushed until the water runs clear. The cleaning time can be extended to up to one week for hardened iron oxides and limescale.
A power flush is a cleaning procedure that cleans the central heating water; the pipes, radiators and boiler that the water runs through. Power flushing and powder flushing are the only modern procedures worth having done.

Power flushing: Uses a power flush machine (creates fast flowing water), chemicals (loosens sludge) and magnets (traps sludge for removal)

POWDER flushing: Uses a powder flush machine (creates even faster flowing water), abrasive powder and magnets (traps sludge for removal)

The old versions of "flushing" are:

Draining the system down with a hose through a drain off cock and letting the water run till clean, sometimes a chemical is added to help loosen up sludge before the drain. This procedure can be called a "system flush", "system cleanse" or "standard flush" and it is not as efficient as modern ones;

Taking the radiators off and washing them individually (does not clean the pipes, boiler, pump, etc.);

Connecting mains water to one side of a radiator valve and a drain hose to the other (subject to system pressure, location of radiator and no chemicals can be used to improve the results, also hard to move sludge when it is cold and compacted). This technique is not legal in many countries, as you risk contaminating your local area's drinking water supply with the bacteria that is already in your central heating water which was never intended for human consumption.

MAINTENANCE AND MANAGEMENT ASPECTS

It is a maintenance issue to keep track of the condition of the burners, as well as the rest of components which form the heating system.

TIPS AND ATTENTION POINTS

No particular attention point, this intervention is a simple maintenance operation for the technical staff or the service provider.

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

Mali trg 3,4,5,6,7,8, **Ljubljana, SLOVENIA**	**Number of dwellings** 38 (+9 shps) **Number of floors** 7 **Heated surface** 3640 **Inhabitants** 58 **year of construction:** 1991 **year of implementation of the ESM**: 2010	**Cleaning two boilers (removing sediment, dirt...)**	**Investment & initial costs**	1329 EUR
			Energy costs for heating (Costs are for the whole building, not for the flats separately but also for theshops and office spaces – therefore he values are somewhat misleading)	2008: 8388 EUR, 2009: 8550 EUR 2010: 11046 EUR 2011: 11965 EUR
			Heating energy consumption (only for dwellings)	2008: 228 190 kWh **(N : 197 979 kWh)** 2009: 217 760 kWh **(N : 193 739 kWh)** **Average :** **195 859 kWh** 2010: 234 580 kWh **(N : 189 683 kWh)** 2011: 212 660 kWh **(N : 186 529 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : - 3% 2011 : - 5%

RUNNING MAINTENANCE

ESM: REPLACEMENT / HOT WATER TANK

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Replacement of hot water tank

INITIAL ISSUE RELATED TO THE ESM
Life expectancy for steel boiler and heat insulation is highly variable on average from 20 to 30 years, depending on materials used, quality of installation, regular maintenance and manner of use. Therefore, it is highly recommended that in case of replacement, a modern, energy efficient hot water tank is installed.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Old hot water tanks in comparison to modern hot water tanks have several deficiencies mostly regarding performance and energy efficiency. Old heat boiler tanks were usually steel welded with anti-corrosion protection on inner side and poor heat insulation that met requirements of earlier standards with lower requirements.
There are three major reasons that reduce energy efficiency of old hot water tanks: insufficient heat insulation that results in higher heat loses to surroundings, heat transfer inside hot water tank from warmer upper part to colder lower part thru steel perimeter of the tank and the cooling of hot water due to mixing, that is formed on inlet of cold and circulation of water.

Modern, energy efficient hot water tank has many different solutions for increasing energy efficiency: better external thermal insulation that significantly decreases heat loses, internal thermal insulation that prevents heat transfer from hot to cold water. Hot water tank are made of stainless steel. Cold water inlet and circulation are designed to prevent incoming cold water from mixing with the hot water supply.

MAINTENANCE AND OPERATION ASPECTS

Hot water tanks don't require a lot of maintenance. However, it is necessary to ensure correct inlet water preparation and provide regular overheating periods for hot water thank and entire distribution pipes, to prevent growth of bacteria such legionella. Preventive inspections and cleaning (if necessary) of heat exchangers should be done regularly.

TENANTS' AWARENESS ASPECTS

Installation of modern, energy efficient hot water tank reduces costs for energy, increases reliability of hot water supply, which consequently increases living comfort and health protection of all residents. When replacing hot water tank it is also recommended to install a modern circulation pump, which is a time-and temperature-controlled.

TIPS AND ATTENTION POINTS

☑ IDENTIFY THE NEEDS FOR THE BUILDING

The SHO will have to identify the needs of the building regarding the DHW tanks using the relevant questions:

- what is the volume requested regarding the needs of the tenants.
- what is the available space in order to choose the positioning and the volume of the tank.
- will the system be linked with the central heating or will it be independent?

☑ REGARDING ELECTRICAL DHW TANK, PREFER VERTICAL TANKS TO HORIZONTAL TANKS

In a vertical model, the hot water will be accumulated in the upper part of the tank and will be replaced by the cold water warm the inferior part. The exchange surface between the cold and hot water will be reduced and the thermal loses between the warm water layer and the cold water layer.

☑ IMPLEMENT A GOOD MAINTENANCE REGARDING THE DHW INSTALLATIONS

The energy efficiency for DHW will be impacted by some naturel phenomenoms: scaling and corrosion.
In order to prevent such disorders it is necessary to be attentive to some quality points that will help to slow this phenomenom:

- the use of a soft and treated water (the treatment of the water - chemical, natural, mechanical - will be an option for the SHOs) in order not to accelerate the scaling and corrosion.
- the prevention of incorrect settings temperatures (too high - limited to 60°C) in order to avoid the deterioration of the hot water tank.
- the selection of the tanks regarding their efficiency:
enamelled or galvanized tanks with a magnesium anode.
- copper tank with a non-oxydig alloy.
- copper ducts.

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

bauverein AG darmstadt  Triere Strasse 2 , Darmstadt, GERMANY	**Number of dwellings** 44 **Number of floors** 5 **Heated surface** 3354 **Inhabitants** 100	**Replacement of of hot water tank with a central heating system;** **exchange of the hot water tank with a better insulation**	**Investment & initial costs/flat**	9 100 EUR
	3 354 m2		**Energy costs for heating**	2005 : 56 255 EUR 2007 : 55 704 EUR
	year of construction: 1972 **year of implementation of the ESM:** 2006		**Energy consumption for DHW**	2005 : 241 496 kWh **(N : 233 425 kWh)** 2007 : 117 359 kWh **(N : 115 431 kWh)**
			Energy consumption for heating	2005 : 838 332 kWh **(N : 810 316 kWh)** 2007 :603 079 kWh **(N : 593 170 kWh)**
			% of energy reduction before/after the implementation of the ESM	Domestic Hot Water : 50%

RUNNING MAINTENANCE

ESM: REPLACEMENT / WATER PIPES

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Replacement of hot and cold water pipes

INITIAL ISSUE RELATED TO THE ESM
The expected life-expectacy of central heating and central hot-water pipes is 30-50 years; depending on the quality of installed material, paying attention to details, maintenance and type of use. Older buildings probably have their pipe systems old, therefore it makes sense, to install new heating systems when refurbishing the buildings.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Older heating pipelines are usually made of steel. After 10 years of use, the inner corrosion sets in, which causes hydraulic resistance. Due to build-up of material on the inner-side of pipelines, the inner diameter of pipes becomes reduced, which reduces the flow in the pipes. These pipelines need periodical cleaning, and they also need to be replaced, as needed. When replacing the pipelines, the thermal insulation of pipes needs to be made in accordance with standards.

Older pipelines for drinking water are usually made of galvanized steel. Depending on the quality of drinking water , inner surface of pipes becomer saturated, sooner or later. The protectice zinc layer starts wearing off. If heating of drinking water is inadequate, the limescale starts releasing carbon dioxide, which increase the acidity of water. CO2 also causes faster dissolution of protective layer of zinc and steel corrosion follows. Inner walls of such pipes are very rough, which increases the possibility of biofilm formation. A biofilm is a layer of small living organisms on inner walls of drinking water pipeline. The nutrients for biofilm can be found in the water, but can also be formed by organic materials and other substances for softening. Biofilm can grow in a newly installed water system in only 14 days.

If a water from a faucer forms aerosols – a fog of small droplets, which contain legionella, and that fog of droplets is absorbed in lungs, it can lead to legionnaires' disease. Therefore, replacement of old water systems is essential not only because of energy reasons, but also because of health concerns. Furthermore; old steel water pipelines have a poor thermal insuation, so the water cools very quickly in them.
The tenants drain a lot of lukewarm water before they get a water of desired temperature. New water pipes (which are from platic, copper or stainless steel) are more smooth, therefore it can have a smaller diameter for the same flow. Thermal insulation should be vastly improved. Circuation of hot and cold water is also required, which improves the quality of water and reduces its consumption.

MAINTENANCE AND OPERATION ASPECTS

Water pipelines require almost no maintenance.
A correct use of pipelines is essential: in pipelines for heating, the water should be appropriate. In water pipelines for drinking, the water should be softened and filtered.
Replacement of water pipelines is a difficult and costly act. It is reasonable to replace the sewage pipes at the same time, unless they are fit for use another 50 years.

TENANTS' AWARENESS ASPECTS

The replacement of water pipes is a big disturbance for residents. The problem is not only, that they are unable to use water in the process, accompanying building works are also very expensive. This is the reason, why this measure should be thoroughly calculated, so the residents will be satisfied with the effects of replacement.

TIPS AND ATTENTION POINTS

☑ TAKE CARE OF THE SPECIFIC POINTS OF THE SYSTEM

The connecting joints have to be treated with a special attention regarding the insulation of the water tank and its network (joints between the pipes, starting point from the pipes, etc.).

☑ REDUCE LENGHT AND DESIGN OF THE SYSTEM

The simpler and the shorter the better (cf. ventilation).

DETAILED ASSESSMENT
Values extracted from a x sample of dwellings

	Number of dwellings	Old steel hot and cold water pipes	Investment & initial costs	58 927 EUR

V parku 8,10,12 and Svornosti 7, Havírov, CZECH REPUBLIC	32 **Number of floors** ? **Heated surface** 1398, m2 **Inhabitants** 61	**replaced with new, insulated plastic pipes.**	**Energy costs for energy consumption**	2008: 6446 EUR 2009: 6328 EUR 2010: 6775 EUR 2011: 6917 EUR 2012: 5120 EUR
	year of construction : 1956 year of **ESM implementation**:2010		**Energy consumption for HW**	2008: 115 415 kWh **(N : 126 036 kWh)** 2009: 102 722 kWh **(N : 111 452 kWh)** **Average :** **118 744 kWh** 2010: 103 728 kWh **(N : 94 169 kWh)** 2011: 101 650 kWh **(N : 111 259 kWh)** 2012: 79 067 kWh **(N : 81 902 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -21% 2011 : - 6% 2012 : - 30%
,Akátová 1,3, Havírov, CZECH REPUBLIC	**Number of dwellings** 32 **Number of floors** 4 **Heated surface** 1653 m2 **Inhabitants** 137	**New water distributions are plastic and insulated.**	**Investment & initial costs/flat**	8996 EUR
			Costs for hot water heating	2007: 15875 EUR 2008: 17616 EUR 2009: 19148 EUR 2010: 17099 EUR
	year of construction : 1992 year of **ESM implementation**: 2010		**Energy consumption for DHW**	2007: 155 382 kWh **(N : 164 518 kWh)** 2008: 157 035 kWh **(N : 171 486 kWh)** 2009: 150 423 kWh **(N : 163 207 kWh)** **Average :** **166 404 kWh** 2010: 140 505 kWh **(N : 127 557 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -23%
	Number of dwellings 36 **Number of floors** 4 **Heated surface**	**Replacement of CW, HW main water pipes.** **Replacement of horizontal pipes, pipes in flats and waste pipes.**	**Investment & initial costs/flat**	49 692 EUR

	1800 m2 **Inhabitants** **74**			
, Puškinova 2,4,6, **Havirov, CZECH REPUBLIC**	**year of construction** : 1961 **year of ESM implementation**: 2009		**Consumption for DHW (m3)**	2008 : HW-1032m3/CW-1614m3 2009 : HW-1071m3/CW-1558m3 2010 : HW-999m3/CW-1486m3
			% of water consumption reduction before/after the implementation of the ESM	2010 : HW : - 5% CW : - 6%

RUNNING MAINTENANCE

ESM: WATER CHEMISTRY

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Replacement of hot and cold water pipes

INITIAL ISSUE RELATED TO THE ESM
The expected life-expectacy of central heating and central hot-water pipes is 30-50 years; depending on the quality of installed material, paying attention to details, maintenance and type of use. Older buildings probably have their pipe systems old, therefore it makes sense, to install new heating systems when refurbishing the buildings.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

In open water systems – such as cooling towers and evaporative coolers – problems such as corrosion, scaling and fouling are apparent to anyone who takes a moment to peek through the access door. In closed water systems – such as heated, chilled and steam loops – the interiors of boilers and pipes are permanently hidden from view. Problems such as corrosion, scaling and fouling can proceed unabated, until systems rupture and fail.

Most maintenance managers know that systems are best protected when the chemistry of the circulating water is routinely monitored and corrected to prevent harmful chemical reactions from doing irreversible damage. In others words, protective monitoring must be applied if systems are to perform for many decades.

Some of the impacts of water chemistry in mechanical looping systems such as heating or cooling systems are:

• Scaling. Water lost from leaky seals, faulty valves, and plumbing work requires systems to draw makeup water, which may contain scale-forming minerals. Scaling is the formation of a thin, plate like piece, lamina, or flake that peels off from a surface of a mechanical system in contact with water, as from the skin. Scaling increases with increasing temperature and increasing pH. Other factors which affect scaling are:

-Reduces Heat transfer efficiencies
-Decrease efficiencies
-Increase Tube failures
-Increases operational costs

• Corrosion is the primary cause of failure in closed systems. Corrosion is the reversion of metal to its stable, oxidized, ore form. Iron, for example, reverts to various oxides we call "rust". Corrosion processes are complex electrochemical reactions, with results ranging from pinpoint penetration to generalized metal loss. Corrosivity of dissolved oxygen in water doubles for every 18 F increase in temperature, and corrosivity of water increases as pH increases and as as conductivity increases. Other effects of corrosion are:

-Destroys system metal
-Reduced heat transfer efficiency
-Produces Leaks in equipment
-Contaminates process fluid
-Increase operational cost.

• White Rust is an accumulation of an appreciable volume of a soft, white, fluffy, non protective zinc corrosion product on galvanized surfaces. Effect of white rust are:
-Equipment Corrosion starts
-Premature failure of the galvanized coated metal

• Fouling is the depositing of accumulation of particles or material on mechanical systems. Fouling products, microbiological particulates, dirt, silt, mud, sand, iron oxides, dust, process leaks, oils, etc. Microbes greatly impact fouling. Some effects of fouling are:

-Reduce heat transfer efficiencies
-Decrease fluid flow
-Increases system pressures
-Increases operational cost

• Microbiological growth is the amplification or multiplication of microorganism. Bacterias of concern are Pseudomonas, Desulfovibrio, Clostridia, Beggiatoa, Sphaerotilus, Gallionella, Legionella plus other microorganisms such as fungi, algae and protozoa.

Technically, all water used in closed loop hydronic heating systems should be tested and treated. Unfortunately, this is not practical nor is it likely to be practiced in the field. Use of non-oxygen barrier pipe, tube or hose does not, in its self, guarantee that there will be failures of ferrous metal parts within the system. It does increase the possibility and therefore warrants the use of water treatment or the elimination of ferrous metal from the system altogether.
The keys to successful application of water treatment are:

1.) sample the water,
2.) thoroughly clean the system,
3.) use correct dosage and formulation, and
4.) perform periodic checks. Use of a water treatment information and test log posted near the boiler is highly recommended. The owner will then have a record of what water treatment was used and when it was last tested.

It must be stated that there are thousands of hydronic radiant systems utilizing non-barrier tube without water treatment and have operated for years without failure due to corrosion. There are also those that have experienced varying degrees of problems. Use of water treatment is an insurance policy. It insures protection for those times when water conditions are ripe for corrosion to take place.

MAINTENANCE AND MANAGEMENT ASPECTS

It is essential to keep a proper level of regular maintenance in a heating system. A sample should be drawn every three months for heated or chilled loops, and every month for steam loops, during the period the system operates. If a system runs just part of the year, sample again right before shut-down to ensure it is protected before it sits idle. System water may be analyzed right at the valve, or collected and returned to a work area for analysis. A one-ounce sample is needed.

- Select a faucet not used to feed chemical into system.
- Open valve and allow fluid to run until its appearance stabilizes.
- Fill sample bottle all the way to the top, cap tightly and close valve.

Seven parameters must be measured, two of which are particular to chilled and steam loops. Portable probes and field test kits are available for five of the parameters. The remaining two are gauged by sight.

-Opacity / Color: An indication of corrosion products, organic matter and particulates present.
-PH: A measure of acidic or basic conditions.
-Sulfite: A measure of Sodium Sulfite in ppm.
-Sarcosinate: A measure of Sodium Lauroyl Sarcosinate in ppm.
-Conductivity: A measure of dissolved inorganic salts in µmhos/cm.
-Freeze Point: Temperature at which fluid freezes in °C (for chilled systems).
-Hardness: A measure of calcium carbonate in ppm (for steam systems).

TIPS AND ATTENTION POINTS

☑ THINK TO IMPLEMENT A WATER TREATMENT AFTER THE IMPLEMENTATION OF A NEW SYSTEM

When replacing a boiler, it is highly advisable to perform a sludging heating circuit at minimum with a simple rinse or by a more efficient method such as hydrodynamic sludging in the case of a very Installation embouée (eg with heated floor).
Drainage network is an opportunity to renovate the way degassing installation and protection equipment (heater, heat exchanger, valves, ...) with devices for the separation of sludge and particles (eg magnetic sludge remover, etc.) and effective filtration.

In addition, water heating system must comply with the usual recommendations based installation: range of pH and hardness, descaling treatment, anti-oxygen inhibitor, ...).

☑ SELECT YOUR DE SLUDING METHOD

Prefer "soft" treatment (to avoid holes into pipes or issuers that may occur).

The desludging of a heating or chilled water occurs in 3 main ways:

- chemical method using specific products injected into the circulating water, operation to be renewed every 5 years for heated floors and 7 years for radiators
- Mechanical method of detaching and cleaning the sludge by injecting high pressure air into the water
- ecological method is to install a specific device permanently on the circuit

Ecological method presents today a growing interest regarding the efficiency of the system for the long-term running of the equipment.

☑ IMPLEMENT A LONG-TERM STRATEGY

Thinking about installing filters, pots sludge and water treatment to maintain the facility in a sustainable state.
Adding a corrosion inhibitor during the refilling.

Ensure that there is no malfunction in the system (defective traps air, water leaks, abnormal discharge through the valve ...) resulting in favorable camp frequent water to slush.

 Le Château (37) - 1, 3, 5, 7, rue des Saules ; 4, 6, 8, 10, 12, 14, rue des Pétroles ; 1, 5, 11, 13, 15, 17, 19, 23, 29, 31, 33, 39, 41, 43, 49, 51, 55, 57, rue du Boulet, Bouchemaine, FRANCE	**Number of dwellings** 25 **Number of floors** 5 **Heated surface** 2393, m2 **Inhabitants** 79	**Individual natural gas boilers (installed between 1989 to 2000) ; radiators.** **Draining of heating pipes / draining and injection of SENTINEL X400 sludge remover product.** **1 visit / year : Cleaning, control and setting of all the elements of the boiler and smoke duct, sweeping of smoke duct, control and setting of thermostat, control and repair of leaks ; on demand : replacement of thermostats, taps and bleeders, all faulty elements.**	**Investment & initial cost**	132,1 / system
			Energy costs for energy consumption	Various : individual dwellings
	year of construction : 1966 **year of ESM implementation**:2010		**Energy consumption for HW**	Various : individual dwellings
			% of energy reduction before/after the implementation of the ESM	60 to 62 kWh/sm/year

RUNNING MAINTENANCE

ESM: WATER SAVING KITS

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY

Use of faucet aerators and shower heads in water appliances, both in bathrooms and kitchens.

INITIAL ISSUE RELATED TO THE ESM

The purpose of this ESM is to reduce the consumption of domestic hot water and cold water with devices which lower the water flow in taps of the houses. At the same time, this would mean a reduction in the energy used to produce domestic hot water (DHW).

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

The aim of this ESM is to provide to tenants water appliances that will help them to save water and energy without reducing the quality and perceived pressure of the water. At the same time, this can be one of the most cost-effective saving measures availables in a building, because some governments and companies have energy-saving policies and provide this kind of devices (in most cases, faucet aerators) for free. SHOs who want to implement this ESM will have to take into account this possibility and gather enough information before purchasing the elements.

There are many kinds of water-saver devices that can be used in a house. These are some of the most common examples:

FLUSH TOILET

Various forms of flush toilets have become widely used in modern times. The amount of water used by modern toilets is a significant portion of personal water usage, totalling as much as about 90 litres of water per capita per day.

When a toilet is flushed, the water leads into sewage and eventually ends in a water treatment plant. Here the water is cleaned and removed of unhealthy parts, sanitized and re-used.

Modern low flush toilet designs allow the use of much less water per flush (6.1 to 4.5 per flush) but may require the sewage treatment system be modified for the more concentrated waste. Dual flush toilet allows the use to select between a flush for urine or droppings saving a significant amount of water over conventional units. You push the flush handle up for one kind of flush and down for the other. In some places users are encouraged not to flush after urination. Flush toilets, if plumbed for it, may also use greywater (water previously used for washing dishes, laundry and bathing) for flushing rather than potable water (drinking water). Some modern toilets pressurize the water in the tank that initiates flushing action with less water usage.

FAUCET AERATORS

A faucet aerator (or tap aerator) is often found at the tip of modern indoor water faucets. Aerators can be simply screwed onto the faucet head, creating a non-splashing stream and often delivering a mixture of water and air that lower the flow of water through the tap. An aerator serves the following purposes:

-Shaping the water stream coming out of the faucet spout.

-Saving water and reducing energy costs.

-Reducing faucet noise.

Faucet aerators are often used in homes with low water pressure in order to increase the perceived water pressure.

SHOWERHEADS

A showerhead is a perforated nozzle that distributes water over solid angle a focal point of use, generally overhead of the bather. A shower uses less water than full immersion in a bath, 80 litres on average for a shower compared to 150 litres for a bath. Some showerheads can be adjusted to spray different patterns of water, although hard water may result in calcium and magnesium deposits clogging the head, reducing the flow and changing the spray pattern. For descaling, various acidic chemicals or brushes can be used or some heads have rubber-like jets that can be manually descaled.

Some governments around the world set standards for water usage and regulate shower heads. For example, in the United States, residential and most commercial shower heads must flow no more than 9.5 litres per minute per the Department of Energy ruling 10 CFR 430. Low-flow shower heads, less than or equal 7.6 litres per minute, can use water more efficiently by aerating the water stream, altering nozzles through advanced flow principles or by high-speed oscillation of the spray stream.

TENANTS' EMPOWERMENT ASPECTS

This ESM is a first step in water-saving measures, with possible impact in the future. If tenants are satisfied with this ESM, they will be more willing to implement other measures concerning water, such as flush toilets or water butts to collect rain water, and they may be followed with further saving measures with larger investments, such as replacing washing machines and dishwashers for low consumption ones. The success of this ESM can greatly vary the conception of saving issues in tenants' minds.

TIPS AND ATTENTION POINTS

☑ IMPLEMENT A MAINTENANCE ROUTINE FOR THESE TYPES OF INNOVATIONS

FAUCET AERATORS

These devices need to be cleaned regularly to remove scale. Similarly, it may be wise to dive periodically in a disinfectant solution to eradicate all form of bacterial growth.

SHOWERHEADS

Same remark regarding tartar removal. When decided to install this type of shower, replace at the same time the flexible existing with a mechanically more resistant flexible.

FLUSH TOILET

These devices may be sensitive to the scaling, which may be harmful for the proper functioning of the mechanism, and eventually cause leaks on flush. It is therefore necessary to monitor the installation regularly.
Pushbuttons that control the onset of hunting are often physically very close, which may interfere with the use rational of this equipment.

SHOs nned to implement a strategy regarding all these points. Having a maintenance contract with a service provider may be a good opportunity to make this maintenance process more secure. It is also an opportunity to have a visit in the dwellings in order to control the general state for the dwelling and to communicate with its tenants.

Water saving kits need also to be gathered with a tenants' awareness proccess in order to inform the tenants and users about how to use it and what can be the potential impacts for these systems.

DETAILED ASSESSMENT
Values extracted from a x sample of dwellings

LE TOIT ANGEVIN Guynemer I (98) - 9, rue Guynemer ; 10, rue Roland Garros, Angers, FRANCE	**Number of dwellings** 58 **Number of floors** 5 **Heated surface** 3702 **Inhabitants** 101	**Installation of Eco-Techniques 2070 kits including : a 5 l/mn or 10 l/mn dual flow frother on kitchen sink's taps ; a VENTURI 5 l/mn frother on washbasin's taps , a 7 l/mn VENTURI shower head ; 2 toilet tank's leak chips.**	**Investment & initial costs**	10 475 EUR
			Energy costs for DHW	2007 : 225 448 kWh **(N : 251 696 kWh)** 2009: 185 988 kWh **(N : 222 933 kWh)**
	year of construction : 1978 **year of ESM implementation**:2008		**Energy consumption for HW**	2008 : CW -1,074/HW-2,473 m3; 2009 : CW -811 / HW- 2,185 m3
			% of energy reduction before/after the implementation of the ESM	Energy for Hot Water : 2009 : -11% Quantities for HW : 2009 : -12%
BO GODT	**Number of dwellings** 56 **Number of floors** 4 **Heated surface** 3611 **Inhabitants** 110	**Installation of water-efficient heads and aerators for showers and faucets. (The installation was organized as an 7 month experiment by the SHO in cooperation with an energy company and a producer of water-effecient heads and aerators)**	**Investment & initial costs**	4000 EUR (2800 paid by the SHO and 1200 sponsored by the energy company and the producer)

 Hammelstruphus, Damagervej 9-21, 2450 Copenhagen SV DENMARK	**year of construction** : 1980 **year of ESM implementation**:2010		**Energy consumption for HW**	2009-2010 only hot water: 4.412 m3 (7 month) 2010 only hot water: 4112 m2 (7 month)
			% of energy reduction before/after the implementation of the ESM	Quantities : 2010 : - 7%
LOGÉAL IMMOBILIÈRE  HAUTE-NORMANDIE	**Number of dwellings** 10 336	**Since several years, LOGÉAL ESTATE is implementing on the occasion of the visit of maintenance valves, aerators on all faucets of its housing stock.**	**Investment & initial costs/flat**	3 to 9 EUR
			Energy consumption for HW	0,72 m3/m2 0,69 m3/m2 This equipment saves between 30% and 70% of the flow water without degradation of comfort.
			% of energy reduction before/after the implementation of the ESM	Quantities : 2010 : - 4%

RUNNING MAINTENANCE

ESM: ENERGY SAVING LIGHTING

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY

Replacement of existing lamps with energy saving ones and division of lighting in common halls in the building.

INITIAL ISSUE RELATED TO THE ESM

The purpose of this ESM is to reduce the electric energy consumption by replacing existing bulbs with energy saving ones while maintaining lighting levels, and dividing the building in different switch on parts for the lighting. removing their dirt, making them more efficient.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Usually lighting consumes a lot of electrical energy every day all around the world. According to the statistics, 20 to 50 percent of total energy consumed in homes and offices are used for lighting. What is surprising is that over 90 percent of the lighting energy expense used for some buildings is unnecessary due to the over-illumination. The cost of lighting can be very realistic. For a single 100 W light bulb, it will cost over 66€ in one year if it is used for 12 hours per day (0.15/kWh). As a result, lighting can take a large part of the energy consumption, especially for large buildings.

There are several approaches we can use to minimize lighting energy usage:

• Specification of illumination requirements for each given use area.
• Analysis of lighting quality to ensure that adverse components of lighting (for example, glare or incorrect colour spectrum) are not biasing the design.
• Integration of space planning and interior architecture (including choice of interior surfaces and room geometries) to lighting design.
• Design of time of day use that does not expend unnecessary energy.
• Selection of fixture and lamp types that reflect best available technology for energy conservation.
• Training of building occupants to use lighting equipment in most efficient manner.
• Maintenance of lighting systems to minimize energy wastage.
• Use of natural light - some big box stores are being built (ca 2006 on) with numerous plastic bubble skylights, in many cases completely obviating the need for interior artificial lighting for many hours of the day.
• Load shedding can help reduce the power requested by individuals to the main power supply. Load shedding can be done on an individual level, at a building level, or even at a regional level.

A compact fluorescent lamp (CFL), also called compact fluorescent light, energy-saving light, and compact fluorescent tube, is a fluorescent lamp designed to replace an incandescent lamp; some types fit into light fixtures formerly used for incandescent lamps. The lamps use a tube which is curved or folded to fit into the space of an incandescent bulb and a compact electronic ballast in the base of the lamp.
Compared to general-service incandescent lamps giving the same amount of visible light, CFLs use one-fifth to one-third the electric power, and last eight to fifteen times longer. For example, a 15-watt compact fluorescent bulb (CFL) emits the same light as a 60-watt incandescent bulb. Some CFL products are even more efficient, needing only three to 13 watts to generate bright light. A CFL has a higher purchase price than an incandescent lamp, but can save over five times its purchase price in electricity costs over the lamp's lifetime. Like all fluorescent lamps, CFLs contain mercury, which complicates their disposal. In many countries, governments have established recycling schemes for CFLs and glass generally.
CFLs radiate a spectral power distribution that is different from that of incandescent lamps. Improved phosphor formulations have improved the perceived colour of the light emitted by CFLs, such that some sources rate the best «soft white» CFLs as subjectively similar in colour to standard incandescent lamps.

Implementation of compact fluorescent lamps (CFL) has to take into account the place where the lamps would be, since on and off cycles affect the length of life of the lamps and therefore bulbs subject to frequent switches can age before its marked theoretical duration, reducing the economic and energy savings. This applies to not frequently used sites such as halls or restrooms. Also it is necessary to avoid placing the bulbs in narrow lamps, since high temperatures also reduce their useful life.

MAINTENANCE AND MANAGEMENT ASPECTS

Energy-saving lamps need less maintenance than incandescent lamps because they have a longer lifetime. However, when this kind of lamp has to be replaced, its disposal needs to be in specified recycling bins since like all fluorescent lamps, CFLs contain mercury.

TIPS AND ATTENTION POINTS

Energy savings regarding lighting will not be included in the AFTER process as the AFTER Consortium has mainly decided to focus on the most important consumptions for their building stocks. These consumptions are energy for heating and for the production of Hot Domestic Water.

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

LE TOIT ANGEVIN  **Les Justices (127) - 25, 27, 29, 31, 33, 35, 37, rue de la Baraterie – Angers, FRANCE**	**Number of dwellings** 114 **Number of floors** - **Heated surface** 2258 **Inhabitants** 101	**Installation of 360° array lighting sensors (6 units) in garages in place of permanent lighting (46 bulbs of 20 W each)**	**Investment & initial costs**	3004 EUR
	year of construction : 1981 **year of ESM implementation**:2009		**Energy for lightening in the common parts**	2008 : 6.79 kWh ; 2009 : 6.74 kWh 2010 : 6.05 kWh
			% of energy reduction before/after the implementation of the ESM	Electric consumptions= -11%

WP5:

REPLACEMENT OF SYSTEMS

This work package is specifically dedicated to the analysis and the optimization of the ventilation, central heating and water heating that have been changed in the 5 last years.

In the regions represented and the buildings considered (residential) in the consortium, cooling is not a very important stake; therefore it will not be in the scope of this WP.

The objective of this WP is to assess the environmental, economic and social performance of the replacement of a system by a new one and, in a second time, to elaborate optimization scenarios to improve the energy performance of the buildings that are concerned by such actions through O&M improvement and tenants' empowerment measures. Assessment methodology regarding system replacement developed in the frame of the Scientific Management (WP1) will be used to evaluate the impact of these actions (hereinafter mentioned as ESM).

These ESM regarding systems have been separated from the ESM linked to punctual retrofitting actions as they are very different in terms of:

- Occurrence: systems take generally around 15 years to recoup (due to their life time) whereas investments on the shell take from 30-40 years to recoup.
- Skills required: the staff that manage the heating, water heating and ventilation systems are specialists; they are part of the "maintenance department" whereas the personnel managing retrofitting are part of the "development and retrofitting department".

Assessed buildings will be classified following simple typologies regarding their shape and their date of construction (5 to 7 typologies, following ESAM IEE project methodology) as these elements are centrals when energy performance and costs of works/maintenance are concerned. This will improve the possibility to learn from the analysis of the different interventions.

Table 7-32: Criteria followed to set the market share trends of the heating technologies

Technologies	*Criteria*
District heating	In the Western countries the penetration does not change across the scenarios (it remains the same as in the reference year) because it is supposed that the energy efficiency improvements will be carried out at the level of the transformation sector. In the Eastern countries in general only the existing buildings are connected to district heating. In some cases a decrease is foreseen in the penetration of district heating in existing buildings (due to the possible phase out of obsolete plants).
Gas boilers	The hypothesis is that: • by 2015 in the Autonomous Progress Scenario for the group 1 countries and in the LPI/HPI Scenarios for the other country groups, 15 % of the sales at EU level are constituted by condensing boilers; • and that up to 2030 this technology represents 100 % of the market also for the group 3 countries. Overall the gas boiler share in the existing and future buildings increases steadily in the Autonomous Progress Scenario, but does not increase or slowly decreases in the LPI Scenario and steadily decreases in the HPI Scenario.
Oil boilers	Residual technology. This market is mainly substituted by the gas boilers.
Coal boilers	Old boilers with a short residual life. This stock should disappear in the Autonomous Progress Scenario around 2010-2015 depending on the country (in some cases like Poland, the coal boiler stock disappears only in the policy scenarios and by the year 2020).
Biomass boilers	This is an option which is more triggered by environment (CO_2 emissions) rather than by energy efficiency considerations. The share of this technology, with the exception of the few cases in which the starting share is very high, is generally kept unaltered. Actually an increase of this market share decreases the average country energy efficiency.
Electricity	Decreasing market substituted by heat pumps
Renewables (solar heating/geothermal)	Strong increase in accordance with the country latitude, especially in future buildings
Heat pumps	Strong increase in all the scenarios but less than that in the SHW systems. In this framework the heat pump constitutes the leading energy driver for the increase of the electricity demand in the sector.

REPLACEMENT OF SYSTEMS

ESM: REPLACEMENT/CONDENSING BOILER

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Recent Low Energy Construction/Installation of supply systems (space heating and domestic hot water)

INITIAL ISSUE RELATED TO THE ESM
The replacement of boiler is always a challenge. New solutions for heating systems ave emerged in order to improve the performance and yield of the boilers.
The condesing boilers are implemented in the housing stock since several years and improve the performance of the system regarding traditonal boilers thanks to the recovery of the waste heat in the flue gases produced by the system.
The objective of the condensing boiler is to improve the efficiency of the heat generation using the energy losings of the system to enhance its performance and reduce its energy consumptions.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

In traditional boilers, the combustion of the energy fuel produces hot gases whom heat potential is transfered to the water circulationg in the system thanks to the action of an exchanger.
During this process, **heat losses are provocked due to several factors**: the difference of temperatures between the hot gases and the air of the combustion and the steam cointained in the gases that are blown into the atmosphere (arising from the chemical reaction of the combustion).

The **condensing boiler will take advantage of the heat potential contained in these gases**. The process of condensing the steam to liquid water thanks to its cooling will extract energy.
This process consists in using the latent heat of the vapor and to distribute it to the water of the heating system. As a result, the condesing boiler will use and extract waste energy resulting from the combustion process to use it for heating.

Gases produced in the burner are cooled in an exchanger condenser where the return water flow is circulating before to enter in the boiler body. **This latent heat will be used in order to preheat the return water before to be heated in thanks to the combustion of the energy fuel in the main part of the boiler**.

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

The **longevity and the performance of the condensing boiler will depend on its maintenance**. A regular (yearly)and controlled (contractual) inspection of the boiler is necessary in order to control the performance of the system. The boiler checking will be gathered with an inspection of the hydraulic circuit in order to prevent scale from forming.
The maintenance and inspection of the boiler will (non- exhaustively) include:

* **heat body** :
- chemical and mechanical cleaning of the heat body.
- checking (replacement if needed) of the joints for the mechanical fittings.
- cleaning of the combustion products in the condensate drain.
- measure of the neutralisation or pH adjustment equipment.

* **integrated pieces**:
- checking of the regulation (flows and temperature for the water thanks to the heating curve).
- checking of the circulation pump.
- checking and cleaning of the smoke extractor.
- checking of the pressure for the expansion vessel.

* **ducting system**:
- removal of the dirt.
- checking of the state and geometry of the ducting system.

* **security**:
- aquastat.
- flowswitch regulator.
- pressure control.
- safety valve.

* **burner**:
- cleaning of the burner.
- checking of the electrodes.
- checking of the gas flow.
etc.

TENANTS' AWARENESS ASPECTS

The improvement of the heating performance leads to a reduction of the consumptions having economic impacts for the tenants.
At a larger «social» scale, the condensing boilers will also - thanks to the reduction of the energy consumptions - help to reduce the emmissions for pollutants resulting from the energy fuel consumption.

TIPS AND ATTENTION POINTS

☑ HAVE A LOW RETURN WATER TEMPERATURE

The **return water temerature has to be as low as possible in order to guarantee an efficient and useful preheat process by the heat**

obtained thanks to the condensing process.
The return temperature has to be inferior to 55°C. Expected temperature is between 35°C and 40°C.

Part of the same effort, the overdimensioning of the system has to be avoided in order to guarantee a good return water temperature.
The balancing and the dimensioning of the system is essential in order to ensure a good performance of the heating system. A good calibration of the heating curves will reduce the heating loses and guarantee a good return water temperature.
In order to secure this process, an exhaustive estimation of the heating loads for the building has to be implemente before the selection for a new boiler.

Cf. WP4 Pilot ESM TR16 for a better focus on the overdimensioning question of the systems.

The radiator system temperatures, as well as district heating network temperatures may vary across the countries and according to the age of the systems.

In order to illustrate the variability of parameters across the world see below some examples of typical design radiator temperatures (supply/return water temperatures):

Country	Design temperatures
Czech Republic	75/65°C
Denmark	70/40°C
Finland	70/40°C
Germany	80/60°C
Korea	70/50°C
Poland	85/71°C
Romania	95/75°C
Russia	95/75°C
Slovenia	80/65°C
Sweden	80/60°C
United Kingdom	82/70°C

The advantages of low temperatures have led to lower temperatures being used today, e.g., 60/45°C, 60/40°C or 55/45°C.
Since the beginning of the 80´s, the temperatures higher than 55°C (60°C in certain cases with district heating) are not recommended or even allowed in some EU countries in new heating systems.
Consequently the low-temperature heating systems have been strongly promoted over the past decades.

One of the important factors affecting the supply and return water temperatures in the radiator is the degree of oversizing of the heating system.
Several studies conducted in EU and also outside EU countries have shown that in general there is a substantial oversizing of the heating systems and of the radiator surfaces in particular. This is due to the overestimation of building heat losses at the design stage. During the construction period the components were often selected in sizes larger than required to ensure safety margins.
The oversizing of heating system is even more distinct after the application of energy saving measures on the building envelope.

After the adjustment of the hydraulic balance in the heating system the optimization measure could consist in decreasing the supply temperature in oversized radiator system.

However, the flow can also be reduced and the system can be adjusted to work as a so-called low-flow system. The comprehensive studies conducted on hydronic heating systems during the past two decades have proved that the return temperature is lowest and TRVs are the most effective in the low-flow systems where the use of the energy content from each unit of water in the district heating network is reaching the highest possible degree. By reducing substantially the flow while maintaining a high supply temperature, a low return temperature can be achieved, however such solution implies high demands on the thermostatic radiator valve (TRV) function, in other words improved opportunities for the radiator controls is a prerequisite. The low flow leads to very low pressure drops in the system and all TRVs thus work at approximately equal differential pressure and with a high authority.

Strengths Automatic adaptation to varying working conditions, such as long-term changes in the primary supply temperature Always striving for lowest possible return Temperature	Weaknesses Prone to abnormalities in the systems (such as hydraulic short circuits and malfunctioning TRVs)
Opportunities Heating energy saving Electric energy saving Reduction of installation costs Increase capacity in heat delivery	Threads Underheated rooms Reduction in the district heating supply temperature can result in an increased district heating return temperature due to an increased flow if the difference between primary and secondary supply temperatures is small

Table 1: Key internal and external factors influencing beahaviour of low-flow systems

Most usual and a quite simple approach is lowering both the supply as well as the return water temperature. Setting the optimum supply temperature in a district heating network must be decided from case to case since it depends on several parameters; such as the returning water temperature resulting from the selected supply temperature, the ratio between the heating system efficiency and supplying and returning water temperature, and the desired flow rate in the network. The supply temperature is of course also dependent on actual heat demand.

☑ CHECK THE COMPATIBILITY OF THE GAS DUCTS

The **condensing of the gases implies to check that the ducts will be adapted** (material - avoid plastic or inox, dimensions, resistance to the pressure) to the smoke removal due to the characteristics of the condensed gas.

☑ INSULATE THE DUCTS AND PIPELINES FOR THE NEW CONNECTION

This insulation will protect the system against heat losses.
Cf. WP4 Water pipes for more information about the treatment of the water pipes bith for heating and Domestic Hot Water

☑ TAKE CARE OF THE ELECTRONIC PART OF THE SYSTEM

In order to obtain a good efficiency of the condensing, the metering part of the system has to be optimized.
The calculation of the heating loads is important in order to obtain good regulation of the system (position of the outdoor temperature sensors, indoor sensors that will be used as a reference temperature, etc.).
Please be aware that the sensors need to be correctly implemented and positionned in the building and the dwelling. When the system is adjusted thanks to a range of sensors (CO2 sensors, etc.), it is very useful to check that the sensors are not hidden behind objects, etc.

Moreover, the building management system that will be implemented on the condensing boiler need to be optimized as it is also representing some electrical consumptions. A special recommandation can be to cut the electric system after the end of the heating season in order not to continue to consume electrical energy for heating system with it is not requested for heating. Such an intervention can reduce the electrical consumption for heating during the spring and winter leading to savings estimated at approximately 2% of the total amount of energy requested for heating.

☑ PREVENT SHORT CYCLES FOR THE BOILER

It is interesting to optimize consumption avoid making too many cycles for the boiler.
When the boiler alternates constantly on / off (succession of short cycles), energy is wasted.
A good programmation is requested in order to prevent this repetition of the cycles for heating.

☑ WHEN USING UNDERFLOOR HEATING ANTICIPATE THE OVERHEATING OF THE SPACE

During the intermediary heating season, when using a underfloorheating, be aware that such type of system can have a stronger inertia. Coupled with the solar gains, this intertia can lead to overheating and has to be anticipated, especially in highly insulated buildings.
This remark is not only concerning condensing boiler but also exist in buildings using district heating system.

☑ THINK ABOUT THE COMPLEMENTARY

IMPLEMENTATION OF PROGRAMMABLE ROOM THERMOSTATS

Programmable room thermostats compare the measured temperature to the set temperature. It acts on a switch that controls the burner, the pump or valve. Itmanages power with more efficiency for tenants proposing a terminal control.

A **programmable timer is most often associated with the thermostat** (a) - and this is highly recommended - to automatically make changes in temperature regime (day, night, frost, ...).

The main benefit is an improved comfort by maintaining a uniform temperature level. Saving energy by recovering free contributions. Automation of repetitive tasks set sequences with the controller.

Do not exempt the installation of thermostatic valves (decentralized control) in any other rooms with different temperature heating.
Never put a thermostatic valve in the room where the thermostat is implemented.
The location of the thermostat must be chosen carefully: avoid placing it on a wall exposed to sunlight, near strong light, near a fresh air mouth, near a door, over to an issuer or near a fireplace approval ... It must be on an inner wall, handy to facilitate any exceptions.

Choose an easy to use device and provide the user with incentives and tips regarding its behaviours.. Choose also devices with power reserve to overcome the power cuts.
Think radio controlled thermostats that prevent the installation of cables. Some thermostats also have an integrated call control for a remote control.

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

 Togliatti 3, Moro 5, Beinasco, ITALY	**Number of dwellings** 105 **Number of floors** 3 **Heated surface** 2523 **Inhabitants** 186	**Installation of a new condensing boiler : n°1 ELCO R 603 + N°1 ELCO R 604**	**Investment & initial costs/flat**	130 750 EUR
			Energy costs for heating	2007: 93 270,16 EUR 2008: 92 834,06 EUR 2009: 93 543,32 EUR 2010: 89 432, 04 EUR
	year of construction: 1982 **year of implementation of the ESM:** 2009		**Heating energy consumption**	2007: 584 560 kWh **(N : 577 498 kWh)** 2008: 598 770 kWh **(N : 598 610 kWh)** 2009: 643 730 kWh **(N : 588 028 kWh)** **Average :** **588 045 kWh** 2010: 622 780 kWh **(N : 562 412 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -5%
 Pasubio 76, Rivoli, ITALY	**Number of dwellings** 24 **Number of floors** 4 **Heated surface** 1701,6 **Inhabitants** 51	**Installation of a new condensing boiler: N° 3 ELCO THISION 35**	**Investment & initial costs**	35 560 EUR
	year of construction: 1972 **year of implementation of the ESM:** 2010		**Heating energy consumption**	2009 : 332 580 kWh **(N : 326 528 kWh)** 2012 : 248 800 kWh **(N : 242 909 kWh)**
			% of energy reduction before/after the implementation of the ESM	2012 : -26%

 Passoni 49, Torino, ITALY	**Number of dwellings** 12 **Number of floors** 4 **Heated surface** 1227 **Inhabitants** 26	**Installation of a new Condensing boiler: N° 2 VIESSMANN VITOCROSSAL 200**	**Investment & initial costs**	36 6000 EUR
	year of construction: 1978 **year of implementation of the ESM**: 2009		**Heating energy consumption**	2008 :192 218 kWh **(N : 192 167 kWh)** 2010 : 166 605 kWh **(N : 150 456 kWh)** 2011 : 153 007 kWh **(N : 150 223 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -22% 2011 : -23%
 Caccia 2, 4, 6 Torino, ITALY	**Number of dwellings** 96 **Number of floors** **10** **Heated surface** 5247,38 **Inhabitants** Not provided	**Installation of a new Condensing boiler: N° 2 VIESSMANN VITOCROSSAL 200**	**Investment & initial costs**	85 000 EUR
	year of construction: 1984 **year of implementation of the ESM**: 2009		**Heating energy consumption**	2007 : 1 154 320 kWh **(N : 1 140 376 kWh)** 2009 : 1 000 350 kWh **(N : 1 000 082 kWh)** 2010 : 816 080 kWh **(N : 736 975 kWh)** 2011 : 954 570 kWh **(N : 937 201 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009 : -12% 2010 : - 35% 2011 : - 18%
 Kölner Straße 18-18c, Darmstadt, GERMANY	**Number of dwellings** 32 **Number of floors** **Heated surface** 2326 **Inhabitants** 70	**Replacement of two central standard boiler from 1990 with a new low temperature boiler and adaption of the performance.** **Total 2 low-temperature boilers with an output of 480 kW jewiels including hot water. As an energy carrier gas is used. The provision of hot water via a circulation conduit including a pump.**	**Investment & initial costs**	74 900 EUR
	year of construction:			

	1969 **year of implementation of the ESM:** 2009		**Energy consumption for heating and DHW**	2007 : 570 995 kWh **(N : 599 729 kWh)** 2008 : 636 120 kWh **(N : 610 373 kWh)** **Average :** **605 051 kWh** 2009 : 594 214 kWh **(N : 585 962 kWh)** 2010 : 518 393 kWh **(N : 441 767 kWh)** 2011 ; 490 952 kWh **(N. 529 078 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009 : -3% 2010 : - 27% 2011 ; - 13%
bauverein AG darmstadt  **Heiheimner Stasse 57-61, Darmstadt, GERMANY**	**Number of dwellings** 30 **Number of floors** 5 **Heated surface** 1610 **Inhabitants** 75	**Replacement of boiler with a central standard boiler from 1982; new gas calorific value boiler and adaption of the performance : modulating gas-condensing boiler, Viessmann Vitodens 200 (Power : 15-54 kW)**	**Investment & initial costs**	19 900 EUR
	year of construction: 1957 **year of implementation of the ESM:** 2010		**Heating energy consumption**	2008 : 207 910 kWh **(N : 199 485 kWh)** 2009 : 198 323 kWh **(N : 195 569 kWh)** **Average :** **197 527** 2010 : 216 302 kWh **(N : 184 329 kWh)** 2011 : 104 403 kWh **(N : 112 511 kWh)** 2012 : 138 587 kWH **(N : 133 031 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : - 7% 2011 : - 43% 2012 : - 22%

 Waldmühlenweg 1, Darmstadt, GERMANY	**Number of dwellings** 5 **Number of floors** **Heated surface** 416 **Inhabitants** 15	Replacement of two central standard boiler from 1990 with a new low temperature boiler and adaption of the performance. Low-temperature boiler Vitogas 200/2008 operated with natural gas and a performance possible from 48 kW	Investment & initial cost	12 376 EUR
	year of construction: 1957 **year of implementation of the ESM:** 2011		Energy consumption for heating and Domestic Hot Water	2010 : 97 062 kWh **(N : 82 714 kWh)** 2011 : 80 711 kWh **(N : 86 979 kWh)** 2012 : 68 820 kWh **(N : 66 061 kWh)**
			% of energy reduction before/after the implementation of the ESM	2011 : + 5% 2012 : -20%
 Viktoriastraße 42, Darmstadt, GERMANY	**Number of dwellings** 17 **Number of floors** 4 **Heated surface** 948 **Inhabitants** 40	With a central boiler from 1981 only for heating, new low temperature boiler only for heating and adaptation of the performance	Investment & initial cost	21 539 EUR
	year of construction: 1956 **year of implementation of the ESM:** 2008		Energy consumption for heating	2007 : 137 896 kWh **(N : 144 835 kWh)** 2008 : 162 099 kWh **(N : 155 538 kWh)** 2009 : 143 530 kWh **(N : 141 537 kWh)-** 2010 : 157 896 kWh **(N : 134 557 kWh)** 2011 : 103 131 kWh **(N : 111 140 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009 : -2% 2010 : -7% 2011 : -23%
LE TOIT ANGEVIN	**Number of dwellings** 42 **Number of floors** **Heated surface** 3031 **Inhabitants** 99	Replacement of boiler, with a with 1 condensation VIESSMANN Vitrocrossal 200 boiler and Vitotronic regulation	Investment & initial cost	106 581 EUR
			Energy costs for heating	2007: 27 281 EUR 2008: 27 137 EUR 2009: 25 179 EUR 2010: 29 351 EUR

 1,3,5 rue de la Chanterie, Beaucouzé, FRANCE	**year of construction:** 1975 **year of implementation of the ESM:** 2006		**Energy consumption for heating**	2005: 127 990 kWh **(N : 131 936 kWh)** 2006: 127 110 kWh **(N : 136 489 kWh)** 2007: 94 310 kWh **(N : 105 290 kWh)** 2008: 118 950 kWh **(N : 142 579 kWh)** 2009: 109 620 kWh **(N : 130 951 kWh)** 2010: 156 710 kWh **(N : 159 745 kWh)**
			% of energy reduction before/after the implementation of the ESM	2007 : -11% 2008 : +8% 2009 : -1% 2010 : +21%
 Belle Poignée, 2bis rue Belle Poignée – 3, 5, rue Legludic, Angers, FRANCE	**Number of dwellings** 21 **Number of floors** **Heated surface** 1397 **Inhabitants** 40	**Improvement of natural gas boilers (with thermostat and pilot flame) with low temperature, accumulation CHAFFOTEAUX Serelia VMC boilers, improvement of thermostats (CHAFFOTEAUX CM07P)**	**Investment & initial cost**	37 555 EUR
			Energy costs for heating	Not provided
	year of construction: 1992 **year of implementation of the ESM:** 2009		**Energy consumption for heating**	Not provided
			Energy consumption for DHW	Not provided
 Chef de Ville I, 17A, 17B, 17G, rue Chef de Ville, Angers, FRANCE	**Number of dwellings** 18 **Number of floors** **Heated surface** 972 **Inhabitants** 28	**Improvement of 13 natural gas SAUNIER DUVAL SD223C boilers with CHAFFOTEAUX Inoa 25 CF low temperature, micro-accumulation boilers, installation of CHAFFOTEAUX CM07P thermostats**	**Investment & initial cost**	7 825EUR
			Energy costs for heating	Not provided
	year of construction: 1954 **year of implementation of the ESM:** 2011		**Energy consumption for heating**	Not provided
			Energy consumption for DHW	Not provided

REPLACEMENT OF SYSTEMS

ESM: REPLACEMENT / DISTRICT HEATING

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Replacement of district heating substation

INITIAL ISSUE RELATED TO THE ESM
Low energy efficiency of old district heating substations may be the result of several different factors. The most current weaknesses of the old district heating systems are : heat losses in the network, high water temperatures in return piping and large consumption of auxiliary electricity. In addition, old substations are usually fitted with tube heat exchangers with high hydraulic resistance, that affects performance. Replacement of old substations with new modern substations, or just replacement of old out of date components is a reasonable measure. It tends to results in better energy efficiency and performance.

Aspects that should be considered before replacement of heating substation are: equipment performance, level of deterioration and energy efficiency of entire system. In case of progressive deterioration of vital elements, replacement of entire substation is economically justified measure.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Heating substation is necessary if temperature regime and/or pressure regime of building differs from district heating-system. Normally, temperatures of supply water from main district heating-network are independent from outside temperatures. On the contrary**, temperature of heating water in building's own heating system is regulated according to outside temperatures**. That is the reason, that district heating substation requires elements for temperature regulation. In case of difference in pressure regime, substation is equipped with heat exchanger.

MAINTENANCE AND OPERATION ASPECTS

Maintenance of thermal stations is divided into annual preventive inspections, particularly at the end of the heating season, random performance controls and condition-based maintenance.
Maintenance, repair, and operations are mostly depended from installed equipment. Usually, water softener system is a part of district heating substation that demands most attention and maintenance.
Remote monitoring and control of all devices in district heating systems allows operators to optimize performance of district heating plants and district heating-system.

TENANTS' AWARENESS ASPECTS

Modern district heating substations generally provide better living conditions for residents (more precise temperature regulation, les noise...). Furthermore, they provide more efficient performance (Intelligent frequency converter circulation pumps, energy efficient heat exchangers, well insulated supply pipes...) that results in lower consumption of auxiliary electricity, lower heating energy demand and lower operating costs.

TIPS AND ATTENTION POINTS

☑ PLAN A REGULAR MAINTENANCE OF THE SYSTEM IN ORDER TO GUARANTEE THE EFFICIENCY OF THE SYSTEM

The tips will depend on the characteristics of the heatig substation. Nevertheless, a common attention point about the regular maintenance of the system must be implemented.
This maintenance will have to be controlled thanks to a specific contractual agreement as mentionned and detailled in the WP3 Factsheets of the AFTER project.

☑ ADAPT YOUR CONTRACT TO THE REGULATION OF YOUR SYSTEM AND THE EFFICIENCY OF YOUR BUILDING

The subscription to the heating system has to be adapted to the efficiency and the heating requested by the housing stock connected to the district heating system. The replacement of the substations and the refurbishment of buildings can have a major impact on the requested heating flow.
The fix costs calculated for the subscription to the district heating system (fix costs calculated on a theoretical contracted capacity - «power charge» which is tied to the contracted capacity or contracted water flow) can be recalculated regarding the new needs for the building.
This updating can be very significative in terms of economic efficiency.

DETAILED ASSESSMENT
Values extracted from a x sample of dwellings

bauverein AG darmstadt  **Esellbornstrasse 1-5, Darmstadt, GERMANY**	**Number of dwellings** 25 **Number of floors** **Heated surface** 1741 **Inhabitants** 60	**Exchange of the district heating station and the hot water tank with a better insulation.** **District heating with clear in store system and a power of 160 kW. The district heating is produced with combined heat and power in the central heating plant ..**	**Investment & initial costs/flat**	19 000 EUR
	year of construction: 1983 **year of implementation of the ESM:** 2009		**Energy consumption for heating**	2007 : 293 484 kWh **(N : 308 253 kWh)** 2008 : 236 479 kWh **(N : 226 908 kWh)** **Average :** **267 580 kWh** 2009 : 247 460 kWh **(N : 244 024 kWh)** 2010 : 213 870 kWh **(N : 182 257 kWh)** 2011 : 214 010 kWh **(N : 230 629 kWh)** 2012 : 218 600 kWh **(N : 209 837 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009 : -9% 2010 : -32% 2011 : -14% 2012 : -22%
SPEKTER poslovanje z nepremičninami  **Gimnazijska cesta 15b, Trbovlje, SLOVENIA**	**Number of dwellings** 76 **Number of floors** 6 **Heated surface** 5374 **Inhabitants** 60	**Replacement of district heating substation** **Old heating sub/station was removed, new heating sub/station was installed (regulations, pumps, calorimetres, accumulators, electrical installation, safety…)**	**Energy costs for heating**	2007: 19 943 EUR 2008: 26 425 EUR 2009: 21 635 EUR 2010: 1st half 12 676 EUR 2010: 2nd half 8 633 EUR 2011: 14 330 EUR
	year of construction: 1988 **year of implementation of the ESM:** 2009		**Investment & initial costs**	not provided
			Heating energy consumption	2007: 421 530 kWh **(N : 403 608 kWh)** 2008: 434 890 kWh **(N : 404 121 kWh)** **Average :** **403 864 kWh** 2009: 373 860 kWh **(N : 342 561 kWh)** 2010: 1st half 245 580 kWh 2010: 2nd half 141 690 kWh **(N : 314 369 kWh)**

				2011: 224 050 kWh **(N : 203 978 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009 : -15% 2010 : - 22% 2011 : problem with the data
SPEKTER poslovanje z nepremičninami **Trg Franca Fakina 1, 1a, 3, 3a, Trbovlje, SLOVENIA**	**Number of dwellings** 82 **Number of floors** 6 **Heated surface** 4800 **Inhabitants** 193	**Replacement of district heating substation** **Old heating sub/station was removed, new heating sub/station was installed (regulations, pumps, calorimetres, accumulators, electrical installation, safety…)**	**Investment & initial costs**	32 822, 99 EUR
			Energy costs for heating	2005: 30 818 EUR 2006: 31 283 EUR 2007: 25 506 EUR 2008: 1st half 16 047 EUR 2008: 2nd half 6242 EUR 2009: 14 029 EUR 2010: 14 656 EUR
	year of construction: 1968 **year of implementation of the ESM:** 2008		**Heating energy consumption**	2005: 739 860 kWh **(N : 597 717 kWh)** 2006: 639 160 kWh **(N : 686 520 kWh)** 2007: 540210 kWh **(N : 517 242 kWh)** **Average :** **600 494 kWh** 2008: 1st half 297 400 kWh 2008: 2nd half 86 690 kWh **(N : 356 915 kWh)** 2009: 242 600 kWh **(N : 222 886 kWh)** 2010: 265 340 kWh **(N : 215 392 kWh)**
			% of energy reduction before/after the implementation of the ESM	2008 : - 40% 2009 : -63% (+ refurbishment) 2010 : -65%
SPEKTER poslovanje z nepremičninami **Trg Svobode 30, 32, Trbovlje, SLOVENIA**	**Number of dwellings** 14 **Number of floors** 6 **Heated surface** 6804 **Inhabitants** 269	**Replacement of district heating substation** **Old heating sub/station was removed, new heating sub/station was installed (regulations, pumps, calorimetres, accumulators, electrical installation, safety…)**	**Investment & initial costs**	36 133 EUR
	year of construction:		**Energy costs for heating**	2004: 30 652 EUR 2005 : 35 201 EUR 2006 : 26 344 EUR 2007 : 1st half 10 211 EUR 2007: 2nd half 9700 EUR 2008 : 29 551 EUR 2009 : 26 324 EUR 2010 : 26 370 EUR

	1980 **year of implementation of the ESM:** 2007		**Heating energy consumption**	2006 : 540 500 kWh **(N : 580 550 kWh)** 2007 : 1st half 216 400 kWh 2007: 2nd half 204 000 kWh **(N : 402 526 kWh)** 2008 : 484 320 kWh **(N : 450 053 kWh)** 2009 : 452 100 kWh **(N : 415 262 kWh)** 2010 : 479 400 kWh **(N : 389 157 kWh)**
			% of energy reduction before/after the implementation of the ESM	2007 : - 30% 2008 : -22% 2009 : -29% 2010 : -33%
SPEKTER poslovanje z nepremičninami  **Sallaumines 9-10a Trbovlje, SLOVENIA**	**Number of dwellings** 169 **Number of floors** 6 **Heated surface** 11 374 **Inhabitants** 468	**Replacement of district heating substation** **Old heating sub/station was removed, new heating sub/station was installed (regulations, pumps, calorimetres, accumulators, electrical installation, safety…)**	**Investment & initial costs**	38 195 EUR
			Energy costs for heating	2004: 37 552 EUR 2005: 46 172 EUR 2006: 47 823 EUR 2007: 1st half 20 365 EUR 2007: 2nd half 21 359 EUR 2008: 62 269 EUR 2009: 58 993 EUR 2010: 56 973 EUR
	year of construction: 1983 **year of implementation of the ESM:** 2007		**Heating energy consumption**	2005: 1 113 880 kWh **(N : 899 880 kWh)** 2006: 979 220 kWh **(N : 1 051 779 kWh)** **Average ;** **975 829 kWh** 2007: 1st half 432 470 kWh 2007: 2nd half 448 560 kWh **(N : 843 572 kWh)** 2008: 991 860 kWh **(N : 921 684 kWh)** 2009: 1 019 450 kWh **(N : 936 608 kWh)** 2010: 1 033 410 kWh **(N : 838 879 kWh)**
			% of energy reduction before/after the implementation of the ESM	2007 : -14% 2008 : -6% 2009 : -4% 2010 : -14%
SPEKTER	**Number of dwellings**	**Replacement of district heating**	**Investment & initial costs**	14 524 EUR

 Trg Franca Fakina 2b, Trbovlje, SLOVENIA	32 **Number of floors** 8 **Heated surface** 2073 **Inhabitants** 99 **year of construction:** 1990 **year of implementation of the ESM:** 2010	**substation** **Old heating sub/station was removed, new heating sub/station was installed (regulations, pumps, calorimetres, accumulators, electrical installation, safety…)**	**Energy costs for heating**	2007: 11 575 EUR 2008: 17 023 EUR 2009: 13 449 EUR 2011: 8 674 EUR
			Heating energy consumption	2007: 244 520 kWh **(N : 234 124 kWh)** 2008: 280 510 kWh **(N : 260 663 kWh)** 2009: 229 610 kWh **(N : 210 951 kWh)** **Average :** **235 246 kWh** 2010: 1st half 137 080 kWh 2010: 2nd half 106 840 kWh **(N : 197 192 kWh)** 2011: 136 000 kWh **(N : 123 816 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -17% 2011 : -48%

REPLACEMENT OF SYSTEMS

ESM: REPLACEMENT / HEAT PUMP

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Replacement of boiler with a renewable energy source – heat pump (air/water)

INITIAL ISSUE RELATED TO THE ESM
The replacement of the combustion plant must be be carefully chosen. Boiler fuel oil, which is 50 years old, is outdated and worn out, so therefore muste be replaced. It is appropriate to choose energy source which has a minimum impact on the environment.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Heating with a heat pump is an energy efficient and environmentally friendly way of heating. Heat pumps are devices that use the heat from the environment (outside air, water, ground) and transform it into useful heat for space heating and water heating.
The heat pump requires a heat transfer medium, that changes its physical state and transfers heat from the surroundings into any heating system. As a working medium in heat pumps refrigerants are being used. heat pumps are seperated according to the source of heat that they use:

- Heat pump water/ water
- Heat pump ground/water

Heat pump air/water (they are useful mainly for heating domestic hot water and to support heating). At low outdoor temperatures, they are less suitable. Dual mode systems are more suitable; at low indoor temperatures using another heat source has to be used (gas boiler, wood, electricity).
Heat pump air/ water using a renewable energy source (heat from the environment) and auxiliary power (electricity) rises temperature of water to appropriate level. On average, heat pumps give triple amount of heat depending on the amount of electricity (one kWh of electricity is awarded by three kWh of heat), depending on the ratio of inlet and outlet temperatures.
Temperature of the heated water is at most about 50°C, which means, that heat pumps are suitable for floor heating in low energy buildings, energy efficient buildings, as well as for the preparation of hot water. On the market there are also high temperature heat pumps, reaching temperatures of up to 70°C.

In order to reach an optimal efficiency, the building equiped with the heat pump need to have a very good insulation.

MAINTENANCE AND OPERATION ASPECTS

Heat pumps air/water operate automatically and require service checks only once a year, or in the event of failure.
At external temperatature of around freezing point and high relative humidity (mist) there is a build up of ice on the evaporator, which obstructs the flow of air through the radiator fins. To defrost the ice, it is necessary to invert the heat pump operation from time to time, so the ice melts and the water drains.
When installing the heat pump air/water, take into account the potential source of noise, choose the heat pump which does not exceed the permissible sound level depending on the installed location. Other measures for noise protection must be used such us: anti-noise screens, uneven floors that absorb noise, bushes, ..

TENANTS' AWARENESS ASPECTS

Heat pumps work more efficiently at lower temperatures, so they are suitable for low temperature systems. After installation of heat pump for heating, it is recommended to do the steps for increasing the energy efficiency of buildings and by reducing energy consumption allow operation of the present heating system at a lower temperature level.

TIPS AND ATTENTION POINTS

☑ ADAPT THE RADIATORS

The radiators of the building need to be adapted to the new heat pump. Gentle heat radiators are requested in order to obtain good efficiency ratios for the heat pump.

☑ IMPLEMENT THE HEAT PUMP IN A MACHINE ROOM

Air/Water pumps are quite noisy and need to be positioned outside of the building (but havig a good distance regarding the neighbors) or positioned inside of an acoustically insulated room (the SHO will have to check if the staff for the technical room is large enough to contain all the materials and systems requested for the heat pump and to ensure a possible maintenance).
If not, a good acoustic insulation of the unity is needed in order to prevent noise disorders.
When positioned outside, the heat pump unity need to be protected from the weather conditions (especially from rain and snow) without a rigid connection to the building and separated from the ground.
Take into account when designing the system, studies of noise operating systems and the impact on the environment.
If this preparation has not been well-implemented, corrections can be done regarding noise issues using special sound insulations caps. For example, heat pumps can be dressed with plates in order to prevent the spread of the noise during operation.
-

☑ OPTIMIZE ADDITIONAL REQUESTED ELECTRICITY

The additional electricity required by the heat pump system need to be optimized an limited. The heat pump need to be prioritary regarding the use of this additional electricity. In order to respect this process, the additional electricity support need to be based on the external temperature.

☑ ANTICIPATE THE EVACUATION OF THE WASTE FROM THE SYSTEM

Devices purge air network need to be claimed at the high points of the installation. The work of these additional of traps at high points have been to made by the operator in order to allow to clean the system and ensure its proper working.

☑ IMPLEMENT A GOOD MAINTENANCE STRATEGY

Driving production facilities requires frequent interventions in terms of access and environment:
- Access to heat pump on roof is done by scale and skydome (trap for intermediate dwellings).
- Heat pumps are raised to make visitable the air tightness of the roof.
- Important density of equipment around the heat pump has to be avoided (skydome, parabola, gas pipe, ventilation, pipe condensate flow network glycol solar hot water ...)
- Night Intervention difficult since lack of lighting

DETAILED ASSESSMENT
Values extracted from a x sample of dwellings

SPL www.spl.si Šmartno 68, Šmartno pri Slovenj Gradcu, SLOVENIA	**Number of dwellings** 6 **Number of floors** 3 **Heated surface** 352 **Inhabitants** 13	**Installation of a central heating with a renewable energy source, old oil boiler was replaced with new heat pump air-water TČZ ZV 23 EVT Termotehnika**	**Investment & initial costs**	14 000 EUR
			Overall energy consumption	2010: 57 672 kWh **(N : 46 634 kWh)** 2011: 16 7666 kWh **(N : 14 706 kWh)**
	year of construction : 1963 **year of ESM implementation:** 2010		**% of energy reduction before/after the implementation of the ESM**	2011 : -68%
Logi Pays Place du Fô, 14490 BALLEROY, FRANCE	**Number of dwellings:** 4 **Number of floors** 2 **Heated surface** 337,34 **Inhabitants** 12 **year of construction:** 1983 **year of implementation of the ESM:** 2010	**4 individual houses where electric heating has been changed for heat pumps.**	**Investment & initial costs/flat**	50 197, 60 EUR (including also ventilation and plumbing)
			Normalized nergy consumption for heating	2010: 36 876 kWh **(N : 33 407 kWh)** 2011: 35 100 kWh **(N : 30 105 kWh)**
			% of energy reduction before/after the implementation of the ESM	2011 : -10%
			Costs for maintenance	161, 00 EUR (per dwelling and per year including ventilation).

REPLACEMENT OF SYSTEMS

ESM: REPLACEMENT / WOOD

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Replacement of boiler with wood district heating

INITIAL ISSUE RELATED TO THE ESM
Fuel switching in residential buildings is long term measure therefore it has to be planed carefully and methodically. When such action is taken, it is recommended to replace it with most appropriate energy source. Old out of date oil-fired boilers use environment unfriendly fossil fuels with high emission of carbon dioxide (CO2). Reasonable measure is to replace it with renewable energy sources. Where possible, the preferred option should be connection to a district heating-network. District heating system uses one heating plant to supply heating energy for multiple buildings and entire communities. District heating plant is generally operating with lower running costs, lower emissions and better efficiency in relation to heating appliances in individual buildings. Nonetheless, it is necessary to take into account that district heating system is a mayor investment, and if entire financial burden of investment would be transferred to the users, the price for energy will be high and consumer satisfaction is going to be low.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Transition from individual heating systems to a district heating with concomitant fuel switching preferably from fossil fuels (oil) to renewable energy (wood chips) is a measure that has largest impact on heat production and supply: fossil energy source is replaced with renewable energy and at the same time provides better efficiency in transforming primary energy into useful energy.

MAINTENANCE AND OPERATION ASPECTS

Domestic oil-fired heating appliances in individual buildings have automated regulation. Nonetheless, all heating systems require random performance controls and detailed maintenance. In case of insufficient maintenance, costs for heating energy increases. Increase of costs is usually noticed after the heating season. In addition, every building needs its own boiler room, heating appliance and staff for maintenance, which represents a considerable expense.

Transition from individual heating systems to a district heating reduces necessity for maintenance. Individual building is installed with remote controlled heating substation. Performances of all components of heating substation and all additional heating systems are under permanent supervision of operators in control rooms, which reduces requirements for maintenance.

Central control system for district heating system enables easy and transparent management, monitoring and performance control of all devices in district heating systems. This allows operators to optimize performance of district heating plants and district heating-system and also individual heating substations in buildings. By optimizing performance of individual consumer, we consequently improve performance of the entire system. Central control system also enables real-time error detection for entire system, registers energy consumption and provides data for annual financial statements. Optimized district heating system provides lower running costs, better energy efficiency and lower heating costs for consumers.

TENANTS' AWARENESS ASPECTS

Transition to a different energy source and different heating system is a long term commitment. Residents without reliable information usually avoid making such investments. The main reason is that they do not have clear guarantees about energy prices and dependable information about long term benefits of such investment. Therefore, it is highly important that investors make detailed presentation of performance, benefits, tariff system and costs for such investment. Highest priority for users is with no doubt reliability of service. This means, that customer must be supplied with as much heating energy as building demands at any moment, for price customer expects. If requirements are not met, uncertainties in biomass district heating systems could appear among residents and that could prevent similar investments in the future.

TIPS AND ATTENTION POINTS

☑ THINK ABOUT THE ACCESS TO THE STOCK FOR WOOD

The quality of the access to the storage for wood is important. It represents an important aspect of the practical maintenance and provision for the system.
This aspect includes several requirements such as :

- the security of the storage room : when apenings for the supply of granulated from outside are not secure there is a potential risk (fire) in case of degradation.
- The access of the delivery truck can not properly by implemented during the design phase Designers have to anticipate and to correctly size the road in order to make accessible the room for a truck to go and make a turn.

☑ CONTROL THE QUALITY FOR THE MATERIAL

The quality of the material can reduce the efficiency of the system and create costs for maintenance (dust when the wood is delivered, quantity of ashes after burning process, etc.). The quality of the wood (presence of metal, gravels, etc.) can create issues and degradation in the system (broken screws, obstruction at the alimentation screw, etc.).

It is recommanded to the partners to particularly focus on the quality of the material refering to the national and European norms. Woodchips should be neither too fine nor too big. Fine woodchips can accumulate and create a tap in the boiler and larger woodchips may causes blocking of the screw.

The quality is important, but the ability to be delivered on time is also requested ! The local track may be able to provide the sufficient quantity requested. Before to implement such type of system at a large scale of their housing stock, SHOs need to better understand the organization of the local production for primary resource.

☑ AVOID THE OVERDIMENSIONING

It seems difficult for some typologies to find an adapted dimension of wood boilers. Existing models seems too large or too small to be fully efficient. As a result, wood boilers are not adapted to some buildings and the boilers will be overdimensioned leading to a low-performance for the system.

This overdimensioning problem can be dangerous and lead to « chocking » effect for the boiler (the boiler being block by the security mode due an excess regarding the oxygene supply) or to work with short cycles of operation.

Regarding this point it is important to access the opportunity to implement a wood boiler : rather than installing an oversized boiler functioning lowspeed much of the time, it may be decided to install a smaller woodchip boiler, coupled with a gas boiler.

☑ ANTICIPATE THE VOLUME OF THE STORAGE SILOS

Some issues can be met regarding the storage silos :

- Actual volume different from the expected one.
- Mechanical problems that can lead to a limited use of the silo volume (opening, access to the wood at the bottom of the silo)
- Unloading of the wood leading to problems (compaction, etc.)
-

The storage of the wood need to be controlled thank to quality procedures and the service provider need to be selected regarding their performance.

The tightness of the silo is an important point. Some water infiltrations can lead to failures in the system or degradation (rust, etc.) of some elements of the system. The quality of the wood may also be degraded by the water infiltration and the humidity rate of the material.

☑ WHEN COUPLED WITH A VENTILATION WITH HEAT RECOVERY SYSTEM

In low-energy buildings with a high inertia, the wood pellet heating is very slow to raise and lower the temperature. It better not turn off the heat, but the ventilation with heat recovery in order to adjust the temperature.

DETAILED ASSESSMENT
Values extracted from a x sample of dwellings

	Number of dwellings	Replacement of old oil boiler with wood	Investment & initial costs	Not provided

Trg Prijateljev 3, Ribnica, SLOVENIA	25 **Number of floors** 5 **Heated surface** 1439 **Inhabitants** 65	**biomass district heating system, old boiler was replaced with new bolier, energy source is wood, district heating**	**Energy costs for energy consumption**	2009: 13 629 EUR 2010: 11 500 EUR 2011: 4 819 EUR
	year of construction: 1985 **year of ESM implementation**: 2010		**Energy consumption for heating**	2009: 255 230 kWh **(N : 227 077 kWh)** 2010: 214 005 kWh **(N : 173 046 kWh)** 2011: 135 280 kWh **(N : 118 657 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -24% 2011 : -48%
Sejmisce 7, Mislinja, SLOVENIA	**Number of dwellings** 10 **Number of floors** 3 **Heated surface** 582 **Inhabitants** 27	**Old boiler was replaced with new biomass boiler, energy sources are pellets KWB MULTIFIRE USV D 50**	**Investment & initial costs**	23 895 EUR
			Energy costs for energy consumption	Not provided
	year of construction: 1983 **year of ESM implementation**: 2010		**Energy consumption for heating**	2009 128 160 kWh **(N : 114 023 kWh)** 2011 : 63 700 kWh **(N : 51 508 kWh)**
			% of energy reduction before/after the implementation of the ESM	2011 : -55%
Castelnaudary, FRANCE	**Number of dwellings** 229 **Number of floors** **Heated surface** 17 277 m2 **Inhabitants**	**Wood-burning boiler using wet wood blocks 55% H20.** **Power : 560 kW** **+ 2 gaz boilers. Power : 2880 kW**	**Investment & initial costs/flat**	560 500 EUR
	year of construction: **year of ESM implementation**: 2008		**Cost reduction for energy**	- 132 600 EUR

 Les Grazailles, Carcassone, FRANCE	**Number of dwellings** 348 **Number of floors** **Heated surface** 23497 m2 **Inhabitants**	**Wood-burning boiler using wet wood blocks 55% H20.** **Power : 960 kW** **+ 2 gaz boilers. Power : 2880 kW**	**Investment & initial costs/flat**	857 000 EUR
	year of construction: **year of ESM implementation**: 2008		**Cost reduction for energy**	338 450 EUR

WP6: RECENTLY

REFURBISHED BUILDINGS

This work package is specifically dedicated to the past interventions on existing buildings.

Global retrofitting (intervention on the shell and on the systems) and punctual interventions on the shell (replacement of the windows, partial insulation,...) will be considered and hereinafter designated as ESM-, focussing on the most recent interventions (less than 5 years) but also integrating in the scope some older but relevant measures. The project focuses on buildings with central heating.

The objective of this WP is to assess of the environmental, economic and social performance of the ESM implemented on old buildings (except systems replacement) and, in a second time to elaborate optimization scenarios for these existing buildings through O&M improvement and through tenants' empowerment. Assessment methodology regarding low energy new buildings developed in the frame of the Scientific Coordination (WP2) will be used to evaluate the impact of the ESM.

The observation of retrofitted buildings is one of the core actions of the project. Actually, as described in the Overview on the starting point of the proposed action, SHO, encouraged by their National Housing Federations, by the European, National and local authorities and by the market, are planning important investments for the next 5-10 years to retrofit their housing stock.. In order to build up realistic strategies and to improve their ambitions in terms of energy savings, SHO need to improve the knowledge of the past experiences, especially regarding:

- Punctual interventions on the shell (north façade insulation, replacement of the windows, etc.) that were made without previous energy audits. These interventions were very almost systematic before the EPBD certificates but without a large scale analysis of the actual impact on the energy consumption of the buildings after the end of the building works.

- Very recent experimentations (e.g. to reach the energy performance of a new passive house) of global retrofitting for which the post-investment costs haven't been truly assessed as the interventions were considered as "experimental".

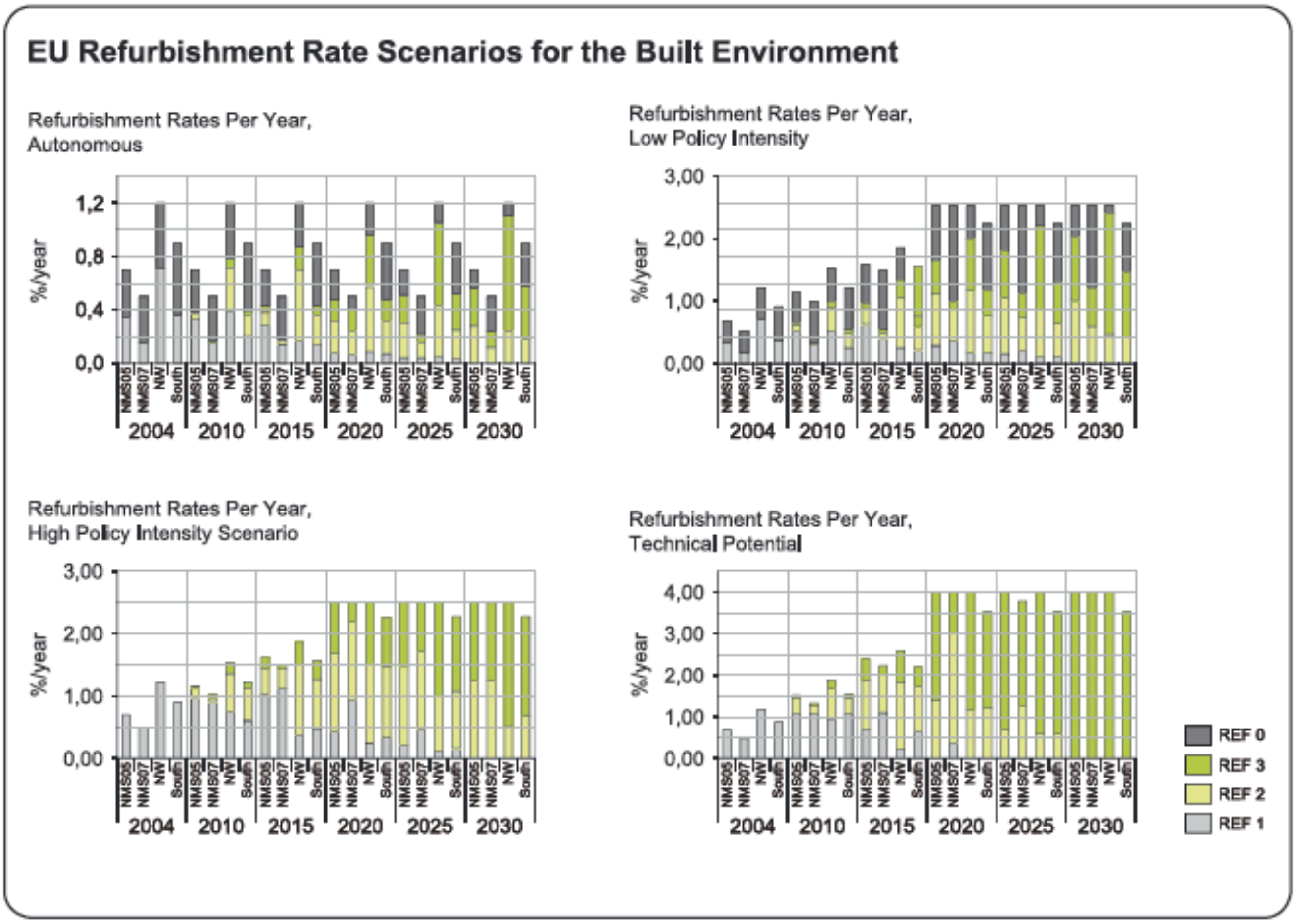

Figure 4 - 18 Illustration of refurbishment rates and implementation of U-values in four scenarios for residential buildings (source Fraunhofer et al., 2009).

RECENT REFURBISHMENT

ESM: REPLACEMENT / GLOBAL APPROACH

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Global approach of a refurbishment process

INITIAL ISSUE RELATED TO THE ESM
The high energy requirements by existing buildings often make necessary a structured and comprehensive energy regeneration intervention, involving all building components, from structure to plants. By the way, everyone agrees that among the first actions aimed at reducing energy consumption shell energy restoration should be included; this allows to increase the insulating capacity and to intervene on the plants in a more proper way.
Thus, the restoration of a building both from the energy and from the environment side is useful and advantageous, for it produces at least seven consequences:

- reduction in heating costs;
- increase in living comfort;
- rise in indoor healthiness;
- enhancement of climate and environment protection;
- increase in the commercial value of the building;
- regional economic revitalization;
- increase in purchasing power.

All things considered, the cost reduction achieved after applying energy improvement measures appears to be significant, allowing savings of up to 2/3 of the previous consumption and a considerable gain in terms of economic perspective and indoor comfort and healthiness.

Energy retrofitting includes all technological and operational actions aimed at improving existing building energy efficiency, i.e. at rationalizing energy flows between the building system (shell + plants) and the external environment.
In general, energy refurbishment of existing buildings is designed to:

• improve indoor comfort;
• reduce energy consumption;
• reduce pollutant emissions and their impact on the environment;
• rationalize the resource use through the exploitation of renewable energy sources instead of fossil fuels;
• optimize energy service management;

The real estate energy refurbishment - related to the sustainability of buildings - is internationally promoted by policies which recognize that a change is needed in the way to design, build, manage and maintain existing buildings, if we want to pursue the environment, health and welfare protection in the building field. The main actions to be undertaken to achieve an advantageous retrofit should affect both the technological system and the building energy management.

These actions basically are:

- improvement of the shell performance (increase in thermal insulation, replacement of windows, installation of appropriate solar shading systems etc.);
- replacement of obsolete components of heating and lighting plants with energy efficient and low emission ones;
- use of the sun energy to produce electricity (photovoltaic) and heat (solar collectors);
- improvement of natural ventilation and passive cooling in order to avoid the use of air conditioning in summer and to limit the electricity consumption;
- review of contracts regulating energy services, providing the introduction of incentives / disincentives;
- introduction of individual accounting in order to increase users' awareness and to induce them to reduce consumption.

All these actions are inventoried in the AFTER Factsheets and are distributed through the several Work Packages of the project. WP6 will mainly focus on the improvement of the shell performance and some interventions on the systems of the building.
As the several interventions accomplished during a refurbishment are difficult to individualize, the Factsheets for WP6 will indentify the different types of interventions implemented on the shell.
The «Global Refurbishment» Factsheet presents some complex operations and mentions the major strategies to focus on before and during refurbishment operations.

GENERIC ESM TECHNICAL DESCRIPTION

The energy consumptions for a building will be impacted studying its thermal evolution of the building an integrating the need for:

- an **efficient system for the production/distribution/diffusion of heating** (will be tackled in the WP5)

- an **efficient conception and using of the passive potential of the building** taking advantage of:

  • the form of the existing building / **key words**: compactness.
  • its exposition to the sun, the size of the open surfaces (winows, etc.) and the potential solar masks that will influence this orientation / **key words**: orientation ; solar masks and solar gains.
  • its inertia potentia (walls and shell with its specific points) thanks to the insulation materials and technical processes implemented / **key words**: insulation ; shell.
  • its fresh air circulation management and the optimization of the natural ventilation / **key words**: ventilation ; crossing appartment, openings.
  • its thermal management (presence, insulation, etc.) of the buffer spaces juxtaposed to the heated spaces / **key words**: buffer spaces.

- an **attention to the summer comfort of the building** with an optimization of the sun protections, good strategy regarding the surfaces regarding that will allow the entrance of the fresh air and the exit of the exhaust air and allow the pressure drop between the indoor ambient and the outdoor.

The quality of the shell is the basic condition for the thermal insulation and comfort for a building. The WP6 Factsheets will detail several **different points of the shell that will be important in refurbishment operations**:

- the **walls** (and their external and internal insulation).
- the **flat roof and the attics**.
- the **carpentries** (windows, doors), etc.
- **low-floors.**
- **ventilation systems** and networks.

For all these points, Factsheets will be developed in order to mention the important technical and maintenance aspects to focus on and to provide information and detailled feedbacks from the SHOs regarding the costs of operations and the correspponding tips that will improve the knowledge about refurbishments.

The thermal insulation for these several points of attention will be developped in the corresponding Factsheets. Some general remarks about insulation can be presented as part for an introduction.

TECHNICAL ASPECTS

The refurbishment of a building includes a reflection on the three important levers that will ensure the thermal quality and performance for a building.

The objective of the insulation is of course to reduce the heat flow circulating from the indoor heated volume (energy savings) to the outdoor and to control the sensation of fresh/hot air when there is a major difference in some points of the building between the inside temperature an the outside temperature.

The **types of insulation material** prefered for every point of the refurbishment will be developed in the corresponding Factsheets. For every insulation material, the SHO will have to take care of its thermal conductivity (λ-factor - capacity to transfer the heat - expressed in W/m.K) and its thermal resistance (R-factor - opposition to a heat flow - expressed in m2.K/W).

The global thermal performance for a surface will be determined by its coefficient of heat transfer (U-factor - expressed in W/M2.K).

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

The improvements reached thanks to a refurbishment can provocke some disorders that will reduce the energy efficiency for a building or for the comfort of its tenants.
Two main elements have to be controlled after a refurbishment in order to avoid some counterbalancing effects that may occur.

HUMIDITY AND MOISTURE

The humidity inside a volume present risks of energy efficiency for the building.
The humidity sensation will lead to an increasing overconsumption of heating in order to counterbalance the sensation of freshness and to allow the evaporation of the water. The **humidity will also lead to a longer ventilation of the heated volume that will cause some additional thermal losings**.
As a consequence, additional insulation of the building (or reduction of its ventilation air flows and volumes) may cause some disorders regarding humidity. This point has to be particularly observed during the conception an the execution of a refurbishment focusing especially on the circulation of air and prevention against the condensation of humidity inside of the walls and at some points specific points of the building.

EXCESSIVE THERMAL SHOCKS

Additional indoor insulation can lead to high temperatures during the summer on the facades the most expose to the sun provocking degradation of the walls due to the thermal expansion effect.

TENANTS' EMPOWERMENT ASPECTS

Notwithstanding the technical performances for the insulation material and techniques, we have to remind the major importance of the tenants behaviors in the general energy efficiency of a refurbished building.

Awareness of the tenants regarding their potential impacts on the ventilation and heating may be implemented in order to guarantee that the refurbishment savings will not be reduced due to the behavioral aspects.

EXTERNAL INSULATION

The thermal insulation of building (commonly called "overcoat") was used first some decades ago. Today it is considered one of the most effective insulation systems for both new and existing buildings - especially regarding buildings with a continuous heating thanks to its efficient correlated inertia. It can be used on all types of walls (civil and industrial buildings, silos or tanks) and is used both in the public and in the private sector.
The external insulation will improve the winter and the summer comfort thanks to the reduction of the cold wall effect during the winter and the reduction of the solar gains during the summer.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

From the technological point of view, **the thermal insulation consists applying an insulating coating (or layer) on the external surface of the building walls**, so as to rectify the thermal bridges and reduce the effects of rapid outdoor temperature variations on the building structure and facing walls. This system allows to keep the outside walls at a higher temperature, thus avoiding condensation phenomena and increasing the indoor comfort. In addition, it avoids occupants' discomfort during the works as this refurbishment is completely external to the building.

Several solutions can be implemented in order to implement external thermal insulations:

- **coating on a glued/mechanically-fixed insulation material** with a finish systems constituted of a first coat (containing a metal/glass fibre mesh) and a second one (finition/waterproff coat).
- **cladding on insulation material** (wood, stones, slates, etc.).
- **insulation material with an integrated skin**.

For example, and In details, **the intervention «coating on a glued insulation material» is made of four steps**:

1. **preparation** of the external building surfaces;
2. **gluing** of insulating panels (nature, consistency and thickness the most suitable according to the desired result) on the external surfaces,
3. **finishing touch with plaster skim two-layer coat**, to be applied "wet-on wet" upon interposition of fiberglass, and
4. **surface finishing treatment**.

The system is made to withstand shocks of some intensity (as proved by perfotest), and is easy-to-fix, in case of damages affecting the insulating material (through blooming and external plaster restoration).
The indoor thermal insulation is applicable both on new and existing buildings, though its natural application is on the existing buildings. From the technological point of view, it consists of a compound panel gluing (e.g. insulation + plasterboard) on the inner side of outside walls.
In detail, the technique requires the wall to be perfectly flat and straight. In case of interventions on the existing, the pre-existing finishes tending to fall off and chalk to be brushed away. Unlike the outer coat, this technique does not correct the thermal bridges and does not allow to maintain the outside walls at a higher temperature.

(source: ENEA – Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile; National agency for new technologies, energy and sustainable economic development).

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

The external insulation is an intervention on the shell, so a workmanlike implementation is necessary to ensure a correct performance. A particular management/ maintenance of the component is not required.

For **a correct management of the component is recommended**:

- a **periodical check of the wear degree of the walls and others visible parts**, including lintels, in order to detect anomalies, cracks and swellings;
- a **periodical check of plasters integrity through visual assessment** in order to find anomalies, such as bubbles, moistures and cracks;
- **don't compromise surfaces integrity with works that can switch their stability and performance**.

The external insulation is also interesting as it will have both a protective and aesthetic effect on the facades and make them more resistant to the water infiltration due to the rain.

As a management principle it will be necessary before the implementation of an external thermal insulation **to check the property status of the building, as the facade of the building will receive an additional tightness due to the new insulated coat** (works may also implies some space occupation).

TENANTS' AWARENESS AND COMFORT ASPECTS

The external thermal insulation will induce some comfort improvings for the tenants. Reducing the cold wall effect, the roof insulation will imrove the thermal comfort and the acoustic comfort for the tenants.

The energy savings realized thanks to the air thickness effort will reduce the energy consumptions and the costs for energy.
The external thermal insulation is interesting in terms of comfort for the tenants as it will not imply a reduction of the living surface.

TIPS AND ATTENTION POINTS

☑ PROCEED TO A CHECKING OF GRIP GRADING OF THE SUPPORT SURFACE

The **support surface must receive an adequate work in order to guarantee a good adherence of the insulation material**.
The link and the adherence between the insulation material and its support will be particularly important in order to assess the maintenance and the interventions that will be necessary in order to guarantee the efficiency of the external thermal insulation.

If the insulation material adherence is realized thanks to mechanical system (steel dowels for example), a grab test must be implemented.

☑ IMPLEMENT A SPECIAL APPROACH REGARDING THE SINGULAR POINTS OF A BUILDING

Some **particular and sensible points of the buildings need a special attention** regarding their external insulation:

- contact wall/low-floor
- contact wall/carpentries
- contact lintel/carpentries
- contact wall/upper-floor
- penetration of the upper roof
- french windows
- contact wall-sloped roof
- roof ducts/windows on sloped roof
- entrance doors
- penetration of ducts through floors.
- etc.

The SHO will have to be very careful regarding the implementation of thermal insulation around these specific points and be aware that the service providers will have relevant book of details regarding insulation of these points.

☑ BE AWARE OF NOT BLOCKING HUmIDITY IN THE EXISTING WALL WITH A TOO MUCH IMPERMEABLE INSULATION MATERIAL

The **insulation material must not present a risk of moisture for the wall and has to allow minimum circulation of air in order to do not block too much humidity**.

☑ IDENTIFY THE GOOD INTERVENTIONS TO IMPLEMENT ACCORDING TO THE STATE OF THE INSULATION

#1: Good adherence between the insulation material and the wall and between the insulation material and the protective coating / simple dirtying due to the pollution, earth projection, potential simple degradation of the faience, etc.:

- washing with medium pressure cold water and drying.
- fungicide program if needed.
- painting if needed.

#2: Good adherence between the insulation material and the wall and between the insulation material and the protective coating / simple crakings of the finishing stage (+ potential crackings of the insulation panels.

- washing with medium pressure cold water and drying.
- fungicide program if needed.
- bridging of the crackings with an adequate material
- complete repointing to guarantee a good tightness
- painting if needed.

#3: Good adherence between the insulation material and the wall and between the insulation material and the protective coating / degradation of the pointings of the insulation panels, degradations of the offset part

- washing with medium pressure cold water and drying.
- fungicide program if needed.
- clipping and elimination of the unefficient adherent parts
- checking of the adherence for the insulation panels and corrections if needed
- filling of the degradations with a gap filler, foam, etc. - depending on the level of the degradation (from a simple intervention to a more complex one including the complete removal after cutting of the degraded insulation and the implementation anf gluying of a new insulation piece).
- reinforcement of the offset if needed
- general resurfacing

WINDOWS

The windows are important and technologically complex parts of the building shell. They are the weak point of the building regarding heat loss.
A window is made of a transparent layer (the glazing -generally indicated with the term glass) fixed on an opaque element (the frame - fixed or movable frame).
High-quality window should allow both to minimize energy losses

and maximize solar gains. Quality aspects are very important in order to ensure the comfort of tenants and to prevent some degraations of the building (to ensure adequate sound insulation, to allow natural ventilation, to be wind and rain proof, to be fire resistant).

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

The **insulating glass is very effective in reducing heat loss**. **Double-glazed windows are made of two glass layers with an air space between them, usually about 16mm wide**. The air space creates an insulating barrier able to keep heat in.
Energy-efficient windows come in a range of frame materials and styles.
The most energy-efficient glass for double glazing is low emissivity (Low-E) glass. It often has an unnoticeable coating of metal oxide, normally on one of the internal panes next to the air space. This lets light and heat in and cuts the amount of heat that can get out.
Very efficient windows use gases such as argon, xenon or krypton in the air space between the glass layers to increase significantly the acustic and thermal insulation.

For all frame materials there are windows available in all energy ratings:

– **PVC frames** are very long-lasting and can be recycled.
– **Wooden frames** have a lower environmental impact, but need maintenance. They are often used in conservation areas where the original windows were timber framed.
– **Aluminium or steel frames** are slim and long-lasting, and can be recycled.
– **Composite frame**s have an inner timber frame covered with aluminium or plastic. This reduces the need for maintenance and keeps the frame weatherproof.

In windows substitution the laying is one of the most important aspect. **Tests on building sites show that the majority of functional abnormalities and disputes, are due to problems linked to way of laying, owing to the degradation of the functional connection between the wall and the window frame**. It is advisable to adopt systems installation, from the point of view of design and construction, that guarantee the performance of the window, its integrity, safety and welfare for user.

The EN 14351-1:2006+A1:2010 is the guideline for windows and doors, with product standard and performance characteristics.

- **choose high-performance windows** that have at least two panes of glass and a low-e coating.
- **choose a low U-factor for better insulation in colder climates**;
- **look for a low solar heat gain (SHGC) coefficient in warm climates**. This is a measure of solar radiation admitted through a window, door, or skylight.
- **select windows with both low U-factors and low SHGCs** to maximize energy savings in temperate climates with both cold and hot seasons.
- **have your windows installed by trained professionals** according to manufacturer's instructions; otherwise, your warranty may be void.

The most common material recommanded for the windows are double-glazing windows with good thermal performances (Uw less than 2 W/m2.K) or glazing with a good performance (Ug less than 1,5 W/m2.K).

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

It is recommended to check and to replace periodically the conditions of the seals placed on the windows bars, replacing them if necessary. Air infiltration from the windows cause excessive air renewals and heat loss. Air infiltration from the frame can be eliminated using silicone.
The installation is crucial for good result of the refurbishment. If the window is loose it will generate heat bridges and inner surfaces reach very low temperatures, with the risk of condensation and mold.
It is recommended to pay attention to the connection between the window frame and the wall.

TENANTS' AWARENESS AND COMFORT ASPECTS

The behaviour and the lifestyle of the tenants could be relevant to guarantee good performance.
The improvement of the airthightness and the better efficiency of the new windows will induce new need regarding the ventilation of the buildings. Following the implementation of new windows it is important to focus o relevant and efficient awareness of the tenants with a better information on how to ventilate their dwellings with the new system.
It is really important **to inform tenants about the necessary opening time for their windows** in order to avoid the moisture risks due to the condensation phenomenon if the building is not sufficiently ventilated. Some tenants' awareness tips and tools about this problem are provided in WP3 Factsheets.

The **replacement of the windows will have impacts regarding the comfort of the tenants**. The new sound protection may improve the acoustic comfort of the tenants.
Nevertheless, the substitution may also involve some risks for the tenants: more efficiently insulated windows may impact the solar comfort and the warmth, the quality of implementation may also involve some issues regarding the air renewal and the sensation of aircirculation within the building.
The tips provide information about these types of potential disorders.

TIPS AND ATTENTION POINTS

☑ **CHECK THE QUALITY OF THE FIXED FRAME (IF**

CONSERVATION OF THE FIXED FRAME)

The **new window can be implemented with a conservation of the windows frame** if its performance and state is OK. In order to guarantee a good refurbishment, the quality of the frame must be checked in order to take the decision of the conservation of the frame.

Some **major attention points** are:

- factor of **distorsion** of the frame.
- factor of **moisture/oxidation**
- factor of **adherence** to the support.
- general **air tightness** of the frame.
- **compatibility of the new windows** characteristics with the necessary ventilation of the frame.

If a secondary (an heavier) glazzing is implemented thanks to the windows substitution (which is often the case), the SHO will have to be aware of the overweight that will need to be supported by the existing windows frame and adapt its strategy regarding it in order not to cause post-implmentation disorders.

☑ OPERATE A GOOD TIGHTNESS AROUND THE WINDOWS

Notwithstanding the general performance of the facade insulation it is important to be attentive to the water infiltration that can imply a swelling of the coat, plaster panels, insulation material, etc.
A gap can be created due to wrong implementation of the window (wrong filler material, discontinuity on the implementation of the foam rope, irregular work on the contact interfaces).
In order to prevent these disorders, some attention points have to observed regarding the quality and the compatibility of the filler (extension characteristics, dimensions, adherence, lifetime, etc.).
The implementation of the joint must be also correctly realized (it also implies a good work on the contacts support (parralelism, quality and depth of the interstice).

☑ CONCERNING THE CONCRETE CONSTRUCTIONS, USE PRE-ASSEMBLED FRAMEWORK INSERTED DURING THE POURING CASE

☑ MODEL THE WINDOWS EFFICIENCY REGARDING THE STRUCTURE AND ORIENTATION OF THE BUILDING

The windows substitution must be included in a general energy approach and modelling of the building/dwelling. The solar gains must be calculated in order to guarantee the efficiency of the new windows. If new windows with better insulation are implemented, the solar gains will be reduced and may impact the comfort of the dwelling for tenants. These solar gains have to be modelled and an adapted strategy has to be implemented with a ifferential use of the windows characteristics regarding the orientation of the building (reinforced insulation at north, less insulation on the southern facade).
The sun masks have also to be conserved or adapted to the new modelling of the windows performance.

☑ ADAPT THE VENTILATION THROUGH THE WINDOWS

The ventilation has to be adapted regarding the performance of the new windows.
One the most recurrent disorders observed after a new windows implementation consists in the replacement of windows with low air thickness with efficient windows. The **consequences are a reduction of the natural ventilation that may results in some moisture and condensation issues**. As a consequence, a particular attention must be carried out regarding the circulation of air through the new window.
If the building has a natural ventilation an air circulation through the window air has to be implemented in order to ensure the air renewal. If the ancient widows are already equiped with some air outlets, the new windows must be equiped with balanced air outlets that will guarantee to conserve the same air flow rates.

☑ IMPLEMENT AN EFFICIENT STRATEGY REGARDING THE MAINTENANCE AND USE OF THE WINDOWS

The maintenance of the windows will have an important aspect on their efficiency. In order to secure this maintenance the SHO will have to choose a strategy about it. The solutions for this strategy may be very different regarding the level of involvement for the tenants. The SHO can accomplish directly thanks to its staff the essential maintenance actions on the windows or give more initiative to the tenants with some information incentives.

The **essential points regarding the maintenance of the windows** are:

- the **cleaning of the indoor interface** between the wall and the carpentries.
- the **cleaning of the water discharge water**.
- the **cleaning of dust and dirt of the air outlets**.
- the **use of efficient and adapted maintenance products** in order not to damage the integrity of the window.
- the **control of non additional intervention on the joints** and carpentries of the window (paint, degradations, etc.).

☑ TAKE CARE OF A GOOD INSULATION FOR ROLLING SHUTTERS

The **implementation of rolling shutters can reduce the thermal losings and protect for the sun during the summer**.
If such shutters do not exist, their implementation can be an efficient lever. Nevertheless, it will be necessary to take care of the insulation for the rolling shutter casings with some rigid insulation materials and some tightness joints around the casing (but letting air circulation through the frames. A tighten air gap must be respected between the glazing and the shutter in order to reduce air

loses.
When the implementation of rolling shutters is not possible, some additional solutions can be implemented such as
double air curtains.

FLAT ROOF

The design of this intervention requires special attention as a matter of fact, roof insulation is subject to heavy stress both from the atmospheric agents (rain, wind, snow, temperature ranges, solar radiation) and from the workers during construction or maintenance (walking, accidentally dropped tools, etc..).
The main aspects to be considered are the following:
- protection from the weather elements (rain, snow and wind);
- thermal insulation (heat loss through the cover have a major impact on the overall total heating of the building

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

The external thermal insulation of a flat cover is aimed at:

- **reducing the heat losses through the perimeter structures**, thus lowering the costs of winter heating and summer cooling,
- **increase the indoor living comfort**: the insulating material allows the inner cover surface to reach and keep temperatures closer to those of the inhabited environment. It is common knowledge that, when the surface temperature of an internal structure is less than 3 ÷ 4 ° C to that of the living environment, people experience a feeling of discomfort, which is cold, even if the premises are adequately heated, and
- **avoid condensation and mold growth on interior surfaces** of the cover: the moisture in the built environment can condense itself on cold surfaces.

The thermal insulation of the last slab soffit is made of an insulation system adopted in most buildings covered with pitched roofs, with a living attic space. This system is easy to perform and it is used both for new and existing buildings. In addition, it provides a solution also aesthetically valid . From the technological point of view, the laying of the insulator is directly done on the structure of the sloping roof (which may be made of strips of wood, iron or prefabricated joists), also through the use of elements containing the insulation, plaster made prefinished that can be further processed.

Insulation in flat roof with exterior insulation
The flat roof insulation from the outside allows very effective interventions on the coverings that for age or for technical deficiencies are no longer able to ensure the thermal comfort. Depending on the different kind of protection of waterproofing membrane used, the system provides walkable or not walkable coverages. From the technological point of view, the system involves the application, of a new insulating layer above the existing structure (slab, screed to create the gradient, the existing waterproof membrane as vapor barrier), of a new waterproofing membrane and of a protection of the same mantle functional to the use that the coverage should have: expanded clay and gravel and if walkable, paving if not walkable.

Insulation for a flat roof implies some particular observations regarding the quality and the tightness of the insulation material. The exposure of the roof surface is an important aspect to control and wll necessit an efficient insulation material with a R-factor at least higher than 2,4 m2.K/W. The commonly used insulation materials are polyuréthanne (with a tightness of at least 6 cm) or expanded polystyrene (with a tightness of at least 8 com).
The tightness and the quality of the chosen insulation material has to be evaluated considering the weight that the flat roof will have to support regarding the potential climatic conditions.

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

The roof is a part of the shell, so a workmanlike implementation is necessary in order to ensure the proper energetic performance. Flat roofs will be particularly exposed to the consequences of climatic and local conditions that will provocke some expansions and degradation of the waterproof roof protection. As a consequence a particular attention has to be carried out regarding the maintenance of the flat roofs.

For **maintenance, some particular devices are required**:

- **periodical control of visible parts** aimed at finding anomalies that may advance the onset of instability phenomena and structural failure (cracks, injuries);
- **periodical control of the cloak surface conditions**, paying attention to the presence of water stagnation and vegetation above the sealing. It is recommended in particular to check the component during relevant weather events; if necessary, insulation layers can be replaced locally;
- **periodical control of gutters, downspouts and leaf-guard grills**; in particular it's recommended to check the component during relevant weather events and, if necessary, fixing accessories can be replaced locally.

The roof's technical quality is linked to the material's quality of the covering cloak and also to the correct project implementation which takes account of the physical phenomena that the roof is correlated. The climatic conditions of the site and situations of local exposure assume a remarkable importance.

TENANTS' EMPOWERMENT ASPECTS

The roof insulation will induce some comfort improvings for the tenants. Reducing the cold wall effect, the roof insulation will imrove the thermal comfort and the acoustic comfort for the tenants.
The energy savings realized thanks to the air thickness effort will reduce the energy consumptions and the costs for energy.

TIPS AND ATTENTION POINTS

Insulation is one of the most important aspects of buildings design because:

• it helps to maintain a comfortable indoor temperature and, therefore, a suitable working and living environment for the building's users
• it helps to contain costs and energy consumption;
• it contributes the battle against the climate change.

In order to preserve the insulation material characteristics over time, the insulation intrados needs to be always protected by an adequate vapor barrier which must be continuous, without any interruption. Particular attention should be paid to the finish, which must be aesthetically valid.

☑ DO NOT FORGET TO IMPLEMENT NON-COMBUSTIBLE INSULATION AROUND THE CHEMINEES

In order to protect the insulation material and to guarantee its long-term efficiency.

☑ HAVE A GOOD DEFINITION OF THE DEW POINT

The **insulation material should be implemented above the substructure notwithstanding its nature in order to guarantee that the dew point will appear above this substructure** (or the above the existing vapor barrier) and avoid the condensation issues. Nevertheless, a distribution of the insulation material with 2/3 of the thermal insulation resistance above the substructure or the vapor barrier and 1/3 under it can guarantee a dew point above the the vapor barrier (or the substructure).

The **presence of a vapor barrier under the insulation implemented under the substructure is not fully efficient as the vapor barrier may not be perfectly implemented and its continuity may be weaker around some particular points of the building**.
Some designs propose to implement the insulation material under the surface of the base including a ventilated air gap in order to prevent condensation issues. This solution applied in the wood substructure presents some risks of non-performance. Regarding the wood substructure, a vapor barrier must be implemented above the substructure under the insulation material in order to ensure hygrometric exchanges between the wood structure and the outdoor air.

☑ LIMIT THE THERMAL BRIDGES AROUND THE PARAPETS

The **presence of parapets** is a very important point to focus on as the contact between the roof and the wall element below the flat roof extended up past the roof) will create potential thermal breaks due to the pressure between the two components and its particular exposure to climatic conditions.
The end of the heavy insulation of the flat roof at the parapet, the masonry at the joist can be cold during winter time and create condensation with the heated indoor space.
A **special attention has to be carried out in the insulation of the exposed face and/or the top of the parapet** in order to prevent such issues. Due to the variety of parapets and their designs, special solution detaillings can be implemented. The most common solution is to insert some insulation between the roof membrane on the roof side of the parapet and the wall. This complementary insulation aims at bringing the masonry joint at the parapet close to the interior temperature and reduce the condensation risks.

CEILING

The contact between heaten space and unheated space reduces the energy performance of heating. As a consequence, the insulation of the low-floor with a contact with the outdoor or with unheated spaces can improve the comfort thanks to a reduction of the cold wall effect and to reduce the heat losses and the energy consumption.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Type of ceiling insulation:

- Attic ceiling insulation.
- Cellar/Garage ceiling insulation.
- Loose stone foundation.
- Insulation of ceilings over unheated rooms.
- Insulation of the floor extrados.

The most used ceiling insulation system in new buildings is the insulation of the floor covering unheated or basement spaces. It can be applied on any type of ceiling (brick or reinforced concrete slabs, cast on site or prefabricated), after appropriate preparation. From the technological point of view, the system consists in several solutions: implementation of composite panels with fibralith underside ou plaster ; implementation of an insulated sub-ceiling ; implementation of mineral wool flock-spray with a synthetic adhesive. .

This action allows the correction of thermal bridges. The insulation is long lasting, extremely resistant to accidental impacts, easy-to-install and has an appropriate fire response.

In detail, the technique consists in:

- the preparation of the substrate. It needs to be deprived of any roughness and incoherent materials, and made flat enough to be covered with the insulating material.
- the laying of the insulating layer.
- the covering of the insulation layer with a concrete screed, for protective purposes. The screed should preferably be slightly reinforced with an electro-soldered 10x10 cm mesh wire netting, which is the laying surface of the overlying floor.

When an insulation material-panels is used, particular care must be paid to the mutual juxtaposition between the panels. In the case of fibre panels, a layer of water resistance "in container" has to be made above them, in such a way that the concrete casting above it does not cause the total imbibition of the insulating material, with consequent reduction of its insulating characteristics. When light concrete insulating screed is used the laying mixture has to be homogeneous and of appropriate thickness. (source: ENEA)

For an insulation of a ceiling having contact with unheated spaces a good insulation must be implemented. Data is quite the same that the one required in a flat roof insulation.

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

The ceiling insulation is an element forming the shell, so it is necessary the implementation in a workmanlike to ensure the proper performance. A particular management/ maintenance of the component is not required.

TENANTS' AWARENESS AND COMFORT ASPECTS

Insulation of the ceiling may be adapted to particular cases as the adding of some supplementary insulation will reduce the height for a dwelling.
Before the implementation, the necessary tightness of insulation may be calculated in order to be sure that the intervention will not impact the comfort of the tenant.

TIPS AND ATTENTION POINTS

☑ INTEGRATE THE POTENTIAL RISKS FOR DEGRADATION

The **ceiling insulation (especially in the common spaces of a building) can be targeted by voluntary or unvoluntary degradations**. This risk has to be integrated by the SHOs with a special care toward the quality of the materials and some potential additional protections.

☑ PLAN THE SHIFT OF THE LIGHT POINTS

Light points and the light system linked with the insulated low-roof will have to be deplaced.

ATTIC

The design of this intervention requires special attention as a matter of fact, roof insulation is subject to heavy stress both from the atmospheric agents (rain, wind, snow, temperature ranges, solar radiation) and from the workers during construction or maintenance (walking, accidentally dropped tools, etc..).
The main aspects to be considered are the following:

- protection from the weather elements (rain, snow and wind);
- thermal insulation (heat loss through the cover have a major impact on the overall total heating of the building).

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

The thermal insulation of the last slab soffit is made of an insulation system adopted in most buildings covered with pitched roofs, with a living attic space. This system is easy to perform and it is used both for new and existing buildings. In addition, it provides a solution also aesthetically valid. From the technological point of view, the laying of the insulator is directly done on the structure of the sloping roof (which may be made of strips of wood, iron or prefabricated joists), also through the use of elements containing the insulation, plaster made prefinished that can be further processed.

Insulation in flat roof with exterior insulation

The flat roof insulation from the outside allows very effective interventions on the coverings that for age or for technical deficiencies are no longer able to ensure the thermal comfort. Depending on the different kind of protection of waterproofing membrane used, the system provides walkable or not walkable coverages. From the technological point of view, the system involves the application, of a new insulating layer above the existing structure (slab, screed to create the gradient, the existing waterproof membrane as vapor barrier), of a new waterproofing membrane and of a protection of the same mantle functional to the use that the coverage should have: expanded clay and gravel and if walkable, paving if not walkable.

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

The roof is a part of the shell, so a workmanlike implementation is necessary in order to ensure the proper energetic performance. For maintenance, some particular devices are required:

- **periodical control of visible parts aimed at finding anomalies** that may advance the onset of instability phenomena and structural failure (cracks, injuries);
- **periodical control of the cloak surface conditions**, paying attention to the presence of water stagnation and vegetation above the sealing. It is recommended in particular to check the component during relevant weather events; if necessary, insulation layers can be replaced locally;
- **periodical control of gutters, downspouts and leaf-guard grills**; in particular it's recommended to check the component during relevant weather events and, if necessary, fixing accessories can be replaced locally.

The roof's technical quality is linked to the material's quality of the covering cloak and also to the correct project implementation which takes account of the physical phenomena that the roof is correlated. The climatic conditions of the site and situations of local exposure assume a remarkable importance.

TIPS AND ATTENTION POINTS

☑ ADAPT YOUR INSULATION PROCESS TO THE CHARACTERISTICS OF THE ATTIC INSULATION

Some attention points have to be highlighted regarding the insulation of the attics. The insulation realized using flocking process has to be selected very carefully, the excessive ventilation in some attics can cause damages to the adherence of the product.
If the insulation has to be realized between some joists, two layers of insulation have to be implemented .The first one will be implemented between the joists and the second one will be perpendicularly implemented over.

☑ IMPLEMENT EFFICIENTLY THE VAPOUR BARRIERS

The vapour barrier will have to be implemented on the side of the heated volume. By the way, the insulation material must not be protected on its external surface by any plastic film in order not to block up the vapour from the heated space.

VENTILATION

Air quality is a determining factor for comfort and health in indoor environments. A regular change of air is required in order to replace exhausted air with fresh air. Conventionally, in residential buildings air exchange should be 0.4 up to 0.7 volumes/hour.

The ventilation can be natural, through the opening of the windows. The larger the window opening, the more effective the natural ventilation; it is even more effective where a natural draft is created with opposing openings. The disadvantage of the natural ventilation is its discontinuity and its being influenced by many, not easily controllable, factors.
The energy saving buildings potential will be fully exploited only if thermal insulation, energy generation and the building management system are integrated into one complete system. Therefore, it is important that the building's shell is both well-insulated and air-resistant, and able to ensure a good air quality through a mechanical ventilation system.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

A controlled ventilation system provides an adequate supply of fresh air and recovers heat from exhaust air. A controlled ventilation system is useful not only in winter but also in summer, when the weather is very hot.

The **advantages of controlled ventilation** are:

– **energy saving in total needs for heating**;
– **indoor comfort and hygiene**, due to the continuous and gradual introduction of fresh air;
– **improved summer comfort** due to the air cooling through heat exchanging heat with the outside.

There are **two kinds of ventilation systems**:

- **centralized**, for the whole building
- **decentralized**, for single rooms.

Both systems can be equipped with a heat recovery system that allows to transfer the heat from the exhaust outlet air to the fresh inlet air (cf. WP7 Factsheet/Ventilation in order to have a focus on the ventilation with heat recovery systems).
Regarding the nature of the ventilation system, several solutions exist today and are evelopped within the European Social Housing Stock. Basically the most common existing solutions are the following ones:

NATURAL VENTILATION

The natural ventilation works thanks to the principle of the thermal draught (the renewal is provocked by the difference between the outdoor temperature and the indoor temperature and the pressure difference).
The entrance unities are positioned in the low part of the dwelling facade and the extraction units are working thanks to the thermal principle.

Pros:
+ Very simple to implement.
+ Evolutive system: a mechanic controlled system can be easily

added/extraction units can be equiped with some manual control systems or connected to the light (for example in the bathromms or toilets).

Cons:
- No control on the air flows causing a major correlation between the efficiency of the system and the outdoor climatic conditions. There is a potential disconnection between the needs of the dwelling and its tenants in terms of ventilation and the climatic conditions, creating potential overconsumptions or heat losings.
- Not very efficient during the summer
- Quick degradtion of the system efficiency of the extract unit are clogged by the tenants.

MECHANICALLY CONTROLLED SIMPLE FLUX VENTILATION:

Quite common system with **extraction units connected to a duct network that will allow a circulation of the air from the humid parts of the building to the outdoor thanks to mechanical fans**. Entrance units are positioned on the facades of the main rooms. A depression is mechanically created.

Pros:
+ Simple and well-known by the SHOs ensuring an automatic renewal of the indoor air with constant air flows.
+ Air flows can be controlled thanks to a balancing system in order to adapt the system to the needs of the buildings depending on the climatic conditions and the tenants behaviors.

Cons:
- Need to control that the air is well circulating through the system in order to guarantee the performance of the system (non-obstruction of the units and ducts, circulation of the inoor air under the doors, etc.).
- Ventilation will work constantly involving consumption of electric consumptions.

HUMIDITY ASSISTED VENTILATION

Works on the **same model as the MCV system but with an automatic balancing depending on the humidity**. Extraction units positionned in the humid rooms are equiped with some humidity sensors that will control the opening of the extraction units (and air flows) regarding the indoor humidity.

The humidity sensitive ventilation systems are divided **in two types of sub-systems**:

- **dissociation between the entrance unities (fixed air flows) and the extraction unities** (humidity sensitive air flows).
- **association** of the entrance unities (humidity sensitive) and the extraction unities (humidity sensivite).

Pros:
+ Improvement of the quality (both regarding energy savings aspects and comfort aspects) regarding the balancing of the system and better adaptation to the needs.

HEAT RECOVERY VENTILATION

cf. WP7 Factsheet/Ventilation.

NATURAL HYBRID VENTILATION

The **natural hybrid ventilation will associate some elements of the natural ventilation and of the controlled mechanical ventilation**. It is particularly efficient in the refurbishment of collective buildings. The ventilation system is built regarding the principles of the natural ventilation with a mechanical assistance that will be activated when the climatic conditions make it necessary (controlled with temperature, pressure and wind sensors).

Pros:
- Energy savings realized thanks to a ventilation adjusted to the climatic conditions.

Cons:
- More costs regarding a simple ventilation due to the monitoring system.
- Need to reach a good calibration of the system to optimize the system.

GROUND-COUPLED HEAT EXCHANGER

The **ground-coupled heat exchanger is based on the energy inputs of the ground temperature inertia**. During the summer the incoming air circulating in the ducts will use the ground temperature (approximately 20°) to be refreshed. During the winter, the incoming air will be heated thanks to a temperature of the ground more important than the indoor air (12°).

Pros:
- This ground-coupled exchanger will have a complementary action with the heating system and reduce the energy consumptions for heating.
- The ground-coupled exchanger will allow to maintain a minimum security temperature in the vacant houses or apartments.

Cons:
- Complexity of the parameters to optimize this type of systems (volume, air flows, couple with the ventilation system, context: climate and type of ground, dimensioning of the ground-echanger ducts, etc.).
- Heavy maintenance.

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

Because of the current action of the ventilation systems, **extractions get dirty due to the deposits of dust and some polluting elements contained in the vapors.**
This phenomenom will be particularly important in the humid rooms such as kitchens (especially due to the fat cointained in the kitchen smokes) and in the bathrooms.
This degradation will modify the functioning of the extraction units and particularly the volume of the extracted air. It can have important consequences regarding the efficiency of the ventilation system causing some condensation issues, rincreasing the electricty consumption of the mechanically controlled ventilation system and reducing the volume for air renewal and creating an depression in the dwelling.
Consequences in terms of acoustic quality can also be involve (cf. Tenants aspects).

As a consequence, **a regular maintenance of the system has to be implemented and/or controlled by the SHO** and its service provider and/or tenants. This maintenance include the cleaning of the extraction units and the replacement of the ventilation membranes regarding their dirtying.
During the maintenance operations, the SHO will have to check the state of access of the air units (veryfing that they have not get blocked up by the tenants) and their dirtying status.

For more tips on the maintenance of the double-flux ventilation systems (ventilation with heat recovery systems), please cf. the WP7 Factsheet about Heat Recovery Ventilation.

TENANTS' AWARENESS AND COMFORT ASPECTS

The **ventilation system and its maintenance is particularly important regarding tenants aspects**. If the temperature is one major element for the quality and comfort of the tenants, this variable has to be linked with **some other characteristics such as the perception for the air renewal (speed of the air change) and the perception for humidity**. The ventilation system and its efficiency will impact both.
As a consequence, **a good calibration of the air flows and a regular maintenance of the systems in order to control the performance of the ventilation is a necessary element** in order to have an impact on the tenants comfort.
The question of the acoustic comfort is also an important aspect of the comfort for the tenants. It implies a special attention on the location strategy of the extraction units (cf. WP7 Factsheets/Ventilation) and their regular maintenance.

The **Indoor Air Quality** is a raising preoccupation.
Notwithstanding the question of the emission of pollutants (that will implies particular strategies regarding the tenants' information and the selection of the materials used in the building construction and the dwelling interior fixtures), the regular maintenance and the good air flows obtained in the dwellings are a very important attention point in order to prevent some degradations of the Indoor Air Quality in the dwellings and reach a good performance regarding health issues.

In terms of tenants' awareness, this question is linked with the issues tackled in the Maintenance Aspects. The involvement of the tenants is particularly important regarding the questions of ventilation. The regular cleanng of the installation, their non-obstruction is an essential behavior in order to guarantee the good efficiency of the system on a long period.

TIPS AND ATTENTION POINTS

☑ ENSURE RELEVANT AIR FLOWS IN THE SYSTEM

The **relevant air flows have to be measured and implemented both at the commissioning of the building and during its occupation by the tenant**. The objective is to control the performance of the system reducing the pressure drops in the ventilation systems and their noises.
The **air flows are controlled by different types of national legislations**. SHOs will have to work with the service providers in order to prescribe good settings for the balancing of the networks in controlled mechanical ventilation systems. These recommandations will help to ensure the balance between the entrance air flows and the extracted air flows and the circulation of air in the dwelling.

☑ OPTIMIZE THE SIZING AND THE QUALITY OF THE VENTILATION NETWORK

The **length and architecture (elbows, etc.) of the ducts have to be reduced in order to obtain a good sizing of the systems** and to reduce the pressure drops. Rigid conduits will also reduce this risk.

☑ FOCUS ON THE DETECTION AND REPAIR OF THE AIR LEAKS IN THE SYSTEM

The control, detection and repair of the leaks in the ventilation networks is also an essential points in order to ensure the performance of the system and avoid the risks. These leaks can be linked to several causes such as errors during the implementation phase (missing joints or elements) or due to the degradation of the system.
They have to be repaired in some sensible points of the systems: contact between the extraction unit an the duct, contact between the different ducts of the network, etc. The flat-sealing adapter set have to be used in order to obtain a good connexion.

☑ CONTROL THE USE OF THE VENTILATION SYSTEM AFTER THE CONSTRUCTION AND DURING THE TENANTS OCCUPATION

Some **attention points have to be checked regarding the function of the ventilation system**:

- check that the entrance/extraction units have not been blocked up by the tenants or during the construction.
- check that the air is circulating inside the apartment.
- inform the tenants on the necessary activation of the fan and control that the motor is still active.
- possibility to implement a monitoring system in order to have some control points on the air flows within the apartment. This monitoring system can be very simple (implementation of a thermography of the facades in order to see if circulation of the window frames have not been obstructed, sensors inside the apartment to verify the humidity or other parameter, etc.).

The operating aspects of the maintenance are really important to develop. The SHO will have to decide what is the margin for involvement of the tenants. Maintennce contracts regarding ventilation systems are really important to implement with the partners in order to plan regular interventions (at least one cleaning/year for the simple ventilation system, 3 times more for the heat recovery ventilation systems, etc and to distribute the tasks between the SHOs' staff, the service providers and the tenants.

☑ IMPLEMENT AN EFFICIENT ROUTINE REGARDING THE CLEANING OF THE SYSTEM

In the mechanical controlled systems, a regular cleaning of the system must be implemented:

- Units must be cleaned very regularly with a dust removal every 6 months at the entrance points and cleaning of the extraction units with soaped water every 6 months too.
- The fan must be cleaned every year with a visual control of its belt.

☑ PROVIDE MAINTENANCE TIPS TO THE TENANTS

cf WP3 for more focus on the activities toward tenants awareness activities.

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

 **La Baudrie (80) - 32, 34, rue Coubertin ; 12, 14, 16, rue de Verdun ; 19, 21, 23 rue de la Marmitière - 49124 Saint Barthélémy d'Anjou**	**Number of dwellings** 88 **Number of floors** 4 **Heated surface** 5358 **Inhabitants** 155	**External insulation (gables and roof)** **Shuttered, non insulated concrete facades ; double-glazed CPV external carpentries with shutters ; underside insulated lower floor above cellar ; non insulated flat roof and attic floors ; old, natural gas, central heating floor and water-heating system.** **Additional insulation on gables (285 m², R = 2,55 m².K/W) and sloping roof (1 265 m², R = 5,5 m².K/W)**	**Investment & initial costs/flat**	47 348 EUR
			Heating energy costs	2008: 49 420 EUR 2009 : 46 007 EUr 2010 : 46 867 EUR 2011 : 40 207 EUR 2012 : 49 883 EUR
	Year of construction: 1974 **Year of implementation of the ESM:** 2010		**Heating energy consumption**	2008: 673 189 kWh **(N : 806 913 kWh)** 2009: 656 608 kWh **(N : 784378 kWh)** **Average :** **795 645 kWh** 2010: 602 200 kWh **(N : 613 862 kWh)** 2011 : 416 940 kWh **(N : 625 916 kWh)** 2012 : 567 230 kWh **(N : 686 559 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -23% 2011 : -21% 2012 : -14%
 **La Maraîchère I (100) - 20, 25, 32, rue Chouteau ; 32, rue de la Goducière ; 7, rue Périer ; 75, 83, 89, rue Forest - 49800 Trélazé**	**Number of dwellings** 78 **Number of floors** **Heated surface** 4782 **Inhabitants** 112	**Flat roof insulation** **Shuttered, glass wool indoors-insulated concrete facades ; double-glazed 4/12/4, CPV external carpentries with shutters ; insulated (before 1988) attic floor ; ground-laying lower floor ; natural gas central heating and water-heating post 2000 system (power : 346 KW, with regulation, without pilot flame) ; radiators.** **150 mm thick expanded polystyrene flat roof insulation (R = 4,10 m².K/W) and tightness refection**	**Investment & initial costs/flat**	44 484 EUR
			Heating energy consumption	2008 : 489 868 kWh **(N : 587 177 kWh)** 2009: 464 237 kWh **(N : 554 574 kWh)** 2010: 461 032 kWh **(N : 469 960 kWh)**
	year of construction: 1977 **year of implementation of the ESM:** 2009		**% of energy reduction before/after the implementation of the ESM**	2009: - 6% 2010 : - 20%

 **Guynemer I (98) - 9, rue Guynemer ; 10, rue Roland Garros - 49000 Angers**	**Number of dwellings** 58 **Number of floors** **Heated surface** 3702 **Inhabitants** 101	**Windows+ceiling** **Shuttered, insulated, concrete facades ; wooden external carpentries ; non insulated lower floor above garages ; insulated flat roof ; récent central heating and water-heating system ; radiators.** **New windows with double heat protection glass: 619 m² of single-glazed wooden carpentries replaced with double-glazed 4/16/4 Therm + CPV carpentries (Uw = 1,7 W/m².K) with rolling shutters** **Ceiling insulation : 1 089 m² of garage ceiling insulated with a 100 mm thick airplaced flaked mineral fibre (R → 2,4 m².K/W)**	**Investment & initial costs/flat**	Windows: 276461 EUR Ceiling : 19 828 EUR + 3,017.80 (previous insulation removal)
	year of construction: 1975 **year of implementation of the ESM:** 2009		**Heating energy consumption**	2008: 480 742 kWh **(N : 576 238 kWh)** 2009: 575 106 kWh **(N : 687 017 kWh)** 2010: 412 699 kWh **(N : 420 691 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009 : +19% 2010: -27%
 **Mongazon (94) - 22, 24, 26, 28, rue Géricault - 49000 Angers**	**Number of dwellings** 107 **Number of floors** **Heated surface** 7738 **Inhabitants** 214	**Shuttered, glass wool insulated, concrete facades ; shuttered, non insulated, indoors walls ; single-glazed, metal external carpentries with shutters ; insulated (before 1988) flat roof floor ; 50 mm thick insulated lower floor ;** **Replacement of electric heating ceilings with electric radiant heating floors and NFC-certified convectors ; electric water-heaters (5 to 15 years old)** **flat roof insulation : 1 435 m² flat roof insulation R = (4,15 m².K/W)**	**Investment & initial costs**	Flat roof : 215 420 EUR Electric ceilings : 525 558 EUR
	year of construction: 1976 **year of implementation of the ESM:** 2010		**Energy costs for heating**	2008: 48 342 EUR 2009 : 48 462 EUR 2010 : 53 140 EUR 2011 : 47 071 EUR 2012 : 35 275 EUR
			Heating energy consumption	2008: 572 397 kWh **(N : 686 100 kWh)** 2009: 536 686 kWh **(N : 641 121 kWh)** **Average :** **663 611 kWh** 2010: 628 068 kWh **(N : 640 230 kWh)** 2012 : 592 414 kWh **(N : 717 041 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : -9% 2012 : +8%

 **Eventard (94) - 4 & 6 rue Léon Faye ; 2-10 rue Alfred de Musset - 49100 ANGERS**	**Number of dwellings** 133 **Number of floors** **Heated surface** 10 385 **Inhabitants** 303	**Shuttered, glass wool insulated, concrete facades ; shuttered, non insulated, indoors walls ; single-glazed, metal external carpentries with shutters ; insulated (before 1988) flat roof floor ; 50 mm thick insulated lower floor ;** **Replacement of electric heating ceilings with electric radiant heating floors NFC-certified convectors ; electric water-heaters (5 to 15 years old)** **2 462 m² flat roof insulation (R = 3,6 m².K/W)**	**Investment & initial costs**	Flat roof : 313 419 EUR Electric ceilings : 664 765 EUR
	year of construction: 1977 **year of implementation of the ESM:** 2011		**Energy costs for heating**	2008: 58 931 EUR 2009 : 59 166 EUR 2010 : 64 034 EUR 2011 : 58 552 EUR 2012 : 63 758 EUR
			Heating energy consumption	2008: 666 699 kWh **(N : 799 134 kWh)** 2009: 620 359 kWh **(N : 741 076 kWh)** 2010: 694 037 kWh **(N : 707 477 kWh)** **Average :** **749 229 kWh** 2012 : 686 694 kWh **(N : 831 155 kWh)**
			% of energy reduction before/after the implementation of the ESM	2012 : + 10%
 **Estienne d'Orves (66) - 14 boulevard d'Estienne d'Orves - 49000 ANGERS**	**Number of dwellings** 28 **Number of floors** 9 **Heated surface** 2363 **Inhabitants** 78	**Shuttered indoors-insulated concrete facades ; double-glazed 4/16/4 BOUVET CPV external carpentries with shutters ; insulated flat roof floor ; non insulated lower floor above cellar ; recent natural gas central heating (600 KW) and 2 water-heaters (CHAUDAGAZ 70 KW and 40 KW) shared with 2 other buildings (705 KW GUILLON boiler) ; hygrovariable natural ventilation (ACTHYS Aereco grids) ; 1 lift (6,4 KWh) ; radiators with thermostatic taps** **333,68 m² of 135 mm thick expanded polystyrene insulation (R = 3,70 m².K/W) then covered with a new tightness**	**Investment & initial costs**	8 011,66 EUR + 14,134.68 EUR (removal and preparation of floor) + 10,778.82 (tightness) + 5,065.06 (various devices) + 1,253.68 (internal follow up costs)
	year of construction: 1977 **year of implementation of the ESM:** 2011		**Energy costs for heating**	2010: 10 521 EUR 2011 : 9 534 EUR 2012 : 15 675 EUR
			Heating energy consumption	2010: 343 958 kWh **(N : 350 618 kWh)** 2012 271 935 kWh **(N : 329 142 kWh)**
			% of energy reduction before/after the implementation of the ESM	2012 : -6%

 **1-10 Place Bergson, .Clermont-Ferrand, GERMANY**	**Number of dwellings** 152 **Number of floors** 4 **Heated surface** 10 579 **Inhabitants** Not provided by the SHO	**External shell insulation + Ventilation + Windows** **Additional external thermal insulation (External insulation: thermic insulation: expanded polystyrene: 100mm. ; flat roof. Insulation: 100mm).** **New Double-glazzing windows: Double-glazzing 4mm/12mm/4mm.** **New hybrid ventilation system: hybrid ventilation (VNHy©) is a smart ventilation system offering a compromise between the natural ventilation and the mechanically controlled ventilation. The objective of this system aims at reducing the energy loses and the electricity consumptions for the ventilation auxiliaries.**	**Investment & initial costs**	3 356 177 EUR
	year of construction: 1967 **year of implementation of the ESM:** 2010		**Energy costs for heating**	2009: 36 721 EUR 2010: 35 281 EUR 2011: 31 765 EUR
			Heating energy consumption	2009: 994 224 kWh **(N : 1 063 097 kWh)** 2010: 961 000 kWh **(N : 999 598 kWh)** 2011: 777 336 kWh **(N : 988265 kWh)**
			% of energy reduction before/after the implementation of the ESM	2011 : -8%
 **2-7 rue de l'Aiguillade, .Clermont-Ferrand, GERMANY**	**Number of dwellings** 126 **Number of floors** 7 **Heated surface** 9408 **Inhabitants** Not provided by the SHO	**<u>External shell insulation + Ventilation + Windows</u>** **Building connected to a district heating system (80% wood-20% gas).** **Recently refurbished. Main improvements included :** **Refurbishment of the roof insulation (Thermic insulation FOAMglass / R=3,33 m2.kw).** **External thermic insulation (thermic insulation polystyrene expanse : 120 mm / R = 2,43 m2.kW).** **Windows replacement (wood simple-glazing--> PVC carpentries with double-glazing. UW=1,4 W/m2.K).** **New hybrid ventilation system: cf Factsheet BERGSON**	**Investment & initial costs**	Not provided
	year of construction: 1965 **year of implementation of the ESM:** 2012		**Heating energy consumption**	2009 : 1 255 000 kWh **(N : 1 341 937 kWh)** 2013 : 800 620 kWh **(N : 912 432 kWh)**
			% of energy reduction before/after the implementation of the ESM	2013 : -32%
 **Moskevská 1e, Havirov, CZECH REPUBLIC**	**Number of dwellings** 72 **Number of floors** 13 **Heated surface** 2977 **Inhabitants** 155	External walls are made of panel blocks, building national type T06B **Insulation of building envelope, roof and exchange of windows** **Replacement of two old lifts with new ones.** **Maintenance interventions with: repair of roof, repair of leakages in the roof, sealing joints implementation on house repair of leakage, repair of balconies, sealing of window glasses with putty,**	**Investment & initial costs**	1 419 367 EUR
	year of construction: 1970		**Energy costs for heating**	2007: 30 657 EUR 2008: 32 819 EUR 2009: 30 465 EUR 2010: 30 574 EUR

	year of implementation of the ESM: 2008	**repair of wooden windows frames.**	**Heating energy consumption**	2007: 550 754 kWh **(N : 583 138 kWh)** 2008: 556 699 kWh **(N : 607 928 kWh)** 2009: 455 481 kWh **(N : 494 190 kWh)** 2010: 485 251 kWh **(N : 440 533 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009 : - 16% 2010 : - 25%
Mánesova 24,26,28, Havirov, CZECH REPUBLIC	**Number of dwellings** 36 **Number of floors** 4 **Heated surface** 1767 **Inhabitants** Not provided by the SHO	**<u>External shell insulation + Ventilation + Windows</u>** **External shell insulation:** **• Insulation of the facade: external Thermal Insulation Composite System (ETICS) with polystyrene EPS 70 F, thickness 140 mm.** **• Roof insulation** **• Insulation of the ceiling above basement** **• New plastic windows**	**Investment & initial costs**	590 222 EUR + additional costs (project documentation costs: 16 525 EUR)
			Energy costs for heating	2008: 20 430 EUR 2009: 22 609 EUR 2010: 23 901 EUR 2011: 18 194 EUR
	year of construction: 1962 **year of implementation of the ESM:** 2009		**Heating energy consumption**	2008: 318 625 kWh **(N : 347 946 kWh)** 2009: 324 737 kWh **(N : 352 335 kWh)** 2010: 373 919 kWh **(N : 339 461 kWh)** **Average :** **346 580 kWh** 2011: 238 555 kWh **(N : 261 106 kWh)**
			% of energy reduction before/after the implementation of the ESM	2011 : - 25%
Jedlova 2, Havirov, CZECH REPUBLIC	**Number of dwellings** 60 **Number of floors** 12 **Heated surface** 3160 **Inhabitants** 130	**<u>Windows replacement</u>** **Replacement of old wooden windows with plastic ones with U←=1,4 W/m2K)**	**Investment & initial costs**	248 074 EUR
			Energy costs for heating	2007 - 22 516 EUR 2008 - 22 807 EUR 2009 - 22 938 EUR 2010 - 27 295 EUR
	year of construction:			

	1992 **year of implementation of the ESM:** 2008		**Heating energy consumption**	2007: 410 800 kWh **(N : 434 955 kWh)** 2008: 395 000 kWh **(N : 431 348 kWh)** **Average :** **433 151 kWh** 2009: 353 920 kWh **(N : 383 998 kWh)** 2010: 429 760 kWh **(N : 390 156 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009 : - 12% 2010 : - 10%
 Mánesova 50,52,54 Havířov, **CZECH REPUBLIC**	**Number of dwellings** 54 **Number of floors** 6 **Heated surface** 2530 **Inhabitants** 130	**Windows replacement** **Replacement of old wooden windows with plastic ones with U←=1,4 W/m2K)**	**Investment & initial costs**	176751 EUR
	year of construction: 1963 **year of implementation of the ESM:** 2009		**Energy costs for heating**	2007-15 980 EUR 2008-17 504 EUR 2009-19 688 EUR 2010-22 675 EUR
			Heating energy consumption	2007-288 420 kWh **(N : 305 379 kWh)** 2008- 303 600 kWh **(N : 331 538 kWh)** 2009-313 720 kWh **(N : 340 381 kWh)** **Average :** **325 766 kWh** 2010-371 910 kWh **(N : 337 637 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : + 3%

MRA  Tolsteho 1, 3, 5, Havirov, CZECH REPUBLIC	**Number of dwellings** 34 **Number of floors** 5 **Heated surface** 1716 **Inhabitants** 83	**Insulation of the facade: External Thermal Insulation Composite System (ETICS) with polystyrene EPS 70 F ; thickness 140 mm.** **Perimeter and base area insulated with extruded polystyrene XPS thickness 100 mm. Insulation of basement ceiling with thermal insulation hydrophobic boards from mineral fibres thickness 80 mm. Insulation of the roof with boards from fire-retardant foam polystyrene EPS 100 S Stabil thickness 200 mm. All old wooden windows and balcony doors have been removed and replaced with new multi-chamber plastic windows, balcony doors with double glazing (frame U=1,3 W/m2K, window glass U=1,1W/m2K). Old entrance doors (metal and wooden) replaced with entrance doors made of aluminium profiles U=1,5 W/m2K with safety insulation double glass.**	**Investment & initial costs**	590 221 EUR
			Energy costs for heating	2008: 20 430 EUR 2009: 22 609 EUR 2010: 23 901 EUR 2011: 18 194 EUR 2012 : 14 473 EUR
	year of construction: 1960 **year of implementation of the ESM:** 2010		**Heating energy consumption**	2008: 318 625 kWh **(N : 347 946 kWh)** 2009: 324 737 kWh **(N : 352 335 kWh)** **Average :** **350 140 kWh** 2010 : 373 919 kWh **(N : 339 461 kWh)** 2011 : 238 555 kWh **(N : 261 106 kWh)** 2012 : 214 333 kWh **(N : 222 019 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : - 4% 2011 : -26% 2012 : - 37%
SPEKTER poslovanje z nepremičninami  Trg Franca Fakina 2a, Trbovlje, SLOVENIA	**Number of dwellings** 31 **Number of floors** 8 **Heated surface** 2072 **Inhabitants** 79	**Concrete building with 6cm insulation additionally insulated with 7cm insulation**	**Investment & initial costs**	71774,54EUR
			Energy costs for heating (NB: Monthly heating consumption data multiplied with ESCO's current pricelist (EUR/MWh) at that time. The calculated numbers don't include annual cost of standing charge and annualized connection charge.)	2007 - 3761,23 EUR 2008 - 7027,35 EUR 1st half 2009 - 4875,79 2nd half 2009 - 1617,38 EUR 2010 - 6201,02 EUR 1st half 2011 - 4110,28 EUR
	year of construction: 1990 **year of implementation of the ESM**: 2009		**Heating energy consumption**	2008 - 115930 kWh **(N : 107 727 kWh)** 1st half 2009 - 73880 kWh 2nd half 2009 - 36444 kWh **(N : 101 359 kWh)** **Average :** 2010 - 111268 kWh **(N : 90 323 kWh)** 1st half 2011 - 64351 kWh

			% of energy reduction before/after the implementation of the ESM	2010 : - 17%
SPEKTER poslovanje z nepremičninami **Dom in vrt 45, Trbovlje, SLOVENIA**	**Number of dwellings** 20 **Number of floors** 6 **Heated surface** 1066 **Inhabitants** 42 **year of construction:** 1961 **year of implementation of the ESM**: 2009	**Brick walls building with no insulation insulated with 10cm insulation.**	**Investment & initial costs**	50974,6 EUR + additional costs: 10 584 EUR
			Energy costs for heating	2007 - 5041,95 EUR 2008 - 6896,10 EUR 1st half 2009 - 4411,40 EUR 2nd half 2009 - 1609,22 EUR 2010 - 5661,72 EUR 1st half 2011 - 3723,62 EUR
			Heating energy consumption	2007 - 106510 kWh **(N : 101 982 kWh)** 2008 - 112860 kWh **(N : 104 875 kWh)** **Average :** **103 428 kWh** 1st half 2009 - 66830 kWh 2nd half 2009 - 36260 kWh **(N : 94 713 kWh)** 2010 - 102240 kWh **(N : 82 994 kWh)** 1st half 2011 - 58260 kWh
			% of energy reduction before/after the implementation of the ESM	2009 : - 9% 2010 : - 20%
SPL **Glinškova ploščad 23, Ljubljana, SLOVENIA**	**Number of dwellings** 20 **Number of floors** 5 **Heated surface** 1135 **Inhabitants** 42 **year of construction:** 1981 **year of implementation of the ESM:** 2009	**Concrete prefabricated building with balconies.** **External insulation of the facade with 80 mm of styrofoam (Extruded polystyrene foam XPS)**	**Investment & initial costs**	35 000 EUR
			Energy costs for heating	2008: 4649 EUR 2009:4656 EUR 2010:5449 EUR 2011: 5127 EUR
			Heating energy consumption	2008:126 640 kWh **(N : 109 874 kWh)** 2009:115 400 kWh **(N : 102 671 kWh)** 2010: 111370 kWh **(N : 90 055 kWh)**

				2011: 99 430 kWh **(N : 87 213 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : - 18% 2011 : - 21%
 **Runkova Ulica 2, Ljubljana, SLOVENIA**	**Number of dwellings** 96 **Number of floors** 13 **Heated surface** 7725 **Inhabitants** 218	**External thermal insulation with 10 cm of styrofoam in concrete prefabricated building with flat roof and balconies.**	**Investment & initial costs**	163.000 EUR + additional costs: 1200 EUR
	year of construction: 1971 **year of implementation of the ESM**: 2009		**Heating energy consumption**	2008: 809 610 kWh **(N : 702 422 kWh)** 2009: 694 420 kWh **(N : 617 822 kWh)** 2010: 640 500 kWh **(517 914 kWh)**
			% of energy reduction before/after the implementation of the ESM	2009 : - 12% 2010 : - 26%
AARHUS KOMMUNE  **Centervej 30-56, Lystrup, DENMARK**	**Number of dwellings** 14 **Number of floors** 1 **Heated surface** 924 **Inhabitants** 14-22	**14 houses for senior housing from 1984 are going through a total renovation to upgrade it to a lowenergi housing. Older homes are at 1 level. Erected as through brick building in red brick and a 20-degree unilateral lattice truss structure covered with red tiles.** **Sloping roof insulation. Thermal insulation of roof. Monopitch truss with tile roof. Insulatio, = 400 mm (mineral wool). Facades internal insulation. Composit wall (brickwork – aerated concrete blocks). Insulation = 145 mm (mineral wool).** **Solar panels mounted on the roof.** **New windows with Double Heat protection Glass. Two-light window with gas-filled energy glazing. Glass U=1W/M2K**	**Investment & initial costs**	2.984.390 EUR
	year of construction: 1984 **year of implementation of the ESM:** 2010		**energy consumption**	1/04/2007 to 31/03/2008: 152 221 kWh 1/04/2008 to 31/03/2009: 145 494 kWh 1/04/2009 to 31/03/2010: 165 935 kWh 1/07/2012 to 18/03/2013 59 737 kWh

		(aluminium frame with EPS-foam). New heating system: district heating supplied,direct injected, shunt and thermostat regulated underfloor heating. Balanced mechanical ventilation with heating coil supplied by district heating and heat recovery. Balanced mechanical ventilation with heat recovery, by-pass function and a heating coil. Domestic Hot Water heated via a heat exchanger in direct connexion by district heating.	% of energy reduction before/after the implementation of the ESM	2013 : - 36%
bauverein AG darmstadt  Beckstraße 81-85, Darmstadt, GERMANY	**Number of dwellings** 30 **Number of floors** 3 **Heated surface** 1649 **Inhabitants** Around 70	**2006:** **New heating system with a low temperature central boiler and a power plant** **2010:** **Insulation of the roof with no previous insulation on the roof.**	**Investment & initial costs**	1 414 478 EUR
	year of construction: 1953 **year of implementation of the ESM:** 2007		**Heating energy consumption**	2006 : 413 789 kWH **(N : 419 334 kWh)** 2007 : 408 184 kWh **(N : 428 725 kWh)** **Average :** **424 030 kWh** 2008 : 220 803 kWh **(N : 211 866 kWh)** 2009 : 192 600 kWh **(N : 189 925 kWh)** 2010 : 221 952 kWh **(N : 189 144 kWh)** 2011 : 190 247 kWh **(N : 205 021 kWh)** 2012 : 184 145 kWh **(N : 176 763 kWh)**
			% of energy reduction before/after the implementation of the ESM	2008 : - 50% 2009 : - 56% 2010 : - 56% 2011 : - 52% 2012 : - 59%
bauverein AG darmstadt  Holzhofallee 18-20, Darmstadt, GERMANY	**Number of dwellings** 20 **Number of floors** 3 **Heated surface** 941 **Inhabitants** Around 40	**A building from the 50th with no insultion on the facade.** **Insulation of the facade (30 cm).** **Insulation of the cellar ceiling (10 cm).**	**Investment & initial costs**	Facade: 70 560 EUR + 10 584 EUR Ceiling: 8000 EUR + 1200 EUR
	year of construction:			

	1951 **year of implementation of the ESM:** 2008		**Heating energy consumption**	2006 : 345 786 kWh **(N : 350 420 kWh)** 2007 : 336 978 kWh **(N : 353 936 kWh)** **Average :** **352 178 kWh** 2008 : 132 870 kWh **(N : 127 492 kWh)** 2009 : 129 710 kWh **(N : 127 909 kWh)** 2010 : 60 180 kWh **(N : 51 284 kWh)** 2011 : 66 725 kWh **(N : 71 907 kWh)** 2012 : 73 053 kWh **(N : 70 125 kWh)**
			% of energy reduction before/after the implementation of the ESM	2010 : - 86% 2011 : - 80% 2012 : - 81%
bauverein AG darmstadt  **Holzhofallee 24-24a, Darmstadt, GERMANY**	**Number of dwellings** 20 **Number of floors** 3 **Heated surface** 1174 **Inhabitants** Around 40	**A building from the 50th with no insultion on the facade.** **Insulation of the facade (14 cm).**	**Investment & initial costs**	1 136 901 EUR
	year of construction: 1953 **year of implementation of the ESM:** 2010		**Heating energy consumption**	2008 : 242 865 kWh **(N : 233 035 kWh)** 2009 : 383 298 kWh **(N : 377 975 kWh)** **Average :** **305 505 kWh** 2011 : 152 731 kWh **(N : 130 155 kWh)** 2012 : 157 457 kWh **(N : 169 685 kWh)**
			% of energy reduction before/after the implementation of the ESM	2012 : - 45%
bauverein AG darmstadt	**Number of dwellings** 20 **Number of floors** 3 **Heated surface** 1174 **Inhabitants**	**A building from the 50th with no insultion on the facade.** **New heating system with a low temperature central boiler: a modern central heating with the so-called «satellite stations Homes» which function**	**Investment & initial costs**	110 371 EUR

 **Mathidelstraßê 36-40, Darmstadt, GERMANY**	Around 40 **year of construction:** 1955 **year of implementation of the ESM:** 2008	**as water-based heat exchanger.** **Facades have been provided with a thermal insulation with tinted windows additionally received the apartments in the house n°36-38 in one south-facing balcony. Balconies house n°40 were repaired. Insulation of the basement, ceiling and the roof. Besides the replacement of the outer shell were also fresh and waste pipes completely redone.** **New ventilation system with supply air through the window frame and a central system in the cellar. The building has been equipped with a controlled ventilation system.**		
			Heating energy consumption	2007 : 361 836 kWh **(N : 380 045 kWh)** 2008 : not relevant 2009 : 94 974 kWh **(N : 93 655 kWh)** 2010 : 126 048 kWh **(N : 107 416 kWh)** 2011 : 74 139 kWh **(N : 79 896 kWh)** 2012 : 99 713 kWh **(N : 95 716 kWh)**
			% of energy reduction before/after the implementation of the ESM	2007 : - 72% 2008 : - 79% 2009 : - 75%
 **Via Picco 53-55-62-64, Veneria Reale, ITALY**	**Number of dwellings** 28 **Number of floors** 4 **Heated surface** 1808 **Inhabitants** Around 40	**Windows substitution:** **Existing single glazing were substituted with aluminum windows with double glazing and shutters in PVC** **Implementation of a insulated coat of 80mm applied on this existing building of the 1960's.)**	**Investment & initial costs**	Cf. Pilot ESM PICCO
	year of construction: 1966 **year of implementation of the ESM:** 2008-2010		**Heating energy consumption**	

 Corso Molise 18, **Torino, ITALY**	**Number of dwellings** 40 **Number of floors** 5 **Heated surface** ? **Inhabitants** Around 40	**External insulation, window substitution** **In the frame of a global retrofittig, a 1960's pre-fabricated building with no insulation has been equipped with external double skin wall having 100mm insulation under 6mm ceramic finishes.** **Existing single glazing windows have been substituted with double glazing high performance windows giving a U Value of 2.16 and 2.29 for small size windows located at balconies. Corso Molise 18, and Via Parenzo are part of an integrated project and present similar characteristics.**	**Investment & initial costs/flat**	5 271 959, 48 EUR (with Via Parenzo 55)
	year of construction: 1978 **year of implementation of the ESM:** 2011		**Heating energy consumption**	Not provided by the SHO
 Via Parenzo 55 (1), **Torino, ITALY**	**Number of dwellings** 44 **Number of floors** 6 **Heated surface** ? **Inhabitants** ?	**External insulation, window substitution** **In the frame of a global retrofittig, a 1960's pre-fabricated building with no insulation has been equipped with external double skin wall having 100mm insulation under 6mm ceramic finishes.** **Existing single glazing windows have been substituted with double glazing high performance windows giving a U Value of 2.16 and 2.29 for small size windows located at balconies. Corso Molise 18, and Via Parenzo are part of an integrated project and present similar characteristics.**	**Investment & initial costs**	5 271 959, 48 EUR (with Corso Molise 18)
	year of construction: 1978 **year of implementation of the ESM:** 2011		**Heating energy consumption**	Not provided by the SHO
 Via Parenzo 55 (2), **Torino, ITALY**	**Number of dwellings** 24 **Number of floors** 5 **Heated surface** ? **Inhabitants** ?	**External insulation, window substitution** **n the frame of a global retrofittig, a 1960's pre-fabricated building with no insulation has been equipped with external double skin wall having 100mm insulation under 6mm ceramic finishes. Existing single glazing windows have been substituted with double glazing high performance windows giving a U Value of 2.16 and 2.29 for small size windows located at balconies. Corso Molise 18, and Via Parenzo are part of an integrated project and present similar characteristics.**	**Investment & initial costs/flat**	5 271 959, 48 EUR (with Corso Molise 18)
	year of construction: 1978 **year of implementation of the ESM:** 2011		**Heating energy consumption**	Not provided by the SHO

LOGÉAL IMMOBILIÈRE  **La Chênaie, Bourdainville** **FRANCE**	**Number of dwellings** 7 **Number of floors** 1 **Heated surface** **Inhabitants** 27	**Refurbishment of 7 individual housing :** **External insulation : 170mm EPS (R=5,30 m2K.W)** **Insulation between home and garage : Polyuréthane foam : 93mm** **Insulation of the attic (rockwool : 390 mm)** **New hygro-B ventilation controlled system** **Heat pump air/water + thermostatic valves**	**Investment & initial costs/flat**	Not provided by the SHO
	year of construction: 1973 **year of implementation of the ESM**: 2011		**Heating energy consumption**	**N : 2011 : 406 kWh/m2/y** **N : 2013 : 136 kWh/m2/y**
				2013 : -67%
LOGÉAL IMMOBILIÈRE  **Le Bocage, , Autretot** **FRANCE**	**Number of dwellings** 12 **Number of floors** 1 **Heated surface** **Inhabitants** 27	**External insulation : 170mm EPS (R=5,30 m2K.W)** **Insulation between home and garage : Polyuréthane foam : 80mm** **Insulation of the attic (rockwool : 390 mm)** **New hygro-B ventilation controlled system** **Heat pump air/water + thermostatic valves**	**Investment & initial costs/flat**	552 000 EUR
	year of construction: 1974 **year of implementation of the ESM**: 2012		**Heating energy consumption**	**N : 2011 : 344,84 kWh/m2/y** **N : 2013 : 94,40 kWh/m2/y**
				2013 : -73%
un habitat pour tous sdh 1, 3, 5 rue Charles Bélier, Saint Martin d'Hères.	**Number of dwellings** 36 **Number of floors** 5 **Heated surface** 2051 **Inhabitants**	**Building 1:** **External insulation EPS graphite: 140 mm** **Flat roof: insulation Effigreen Duo 14cm** **Building B:** **External insulation EPS graphite: 8 mm** **Attic: glasswool 32 cm** **Double-glazing windows Uw=1,4W/m2.K** **MCV system hygro B** **Connected to district heating. Radiators with thermostatic valves.**	**Investment & initial costs**	816 696.79 EUR
	year of construction: 1955-1958 **year of implementation of the ESM**: 2011		**Heating energy consumption**	**N : 2010 : 678 881 kWh** **N. : 2012 : 188 692 kWh:**
			Reduction	2012 : - 72%
BO GODT	**Number of dwellings** 1 **Number of floors** 2 **Heated surface**	**Roof : "Solprisme" with solar panels, solar panels and skylights, re-insulation by 40-50 cm rockwool.** **New windows with 3-layer glazing**	**Investment & initial costs**	401 651.79 EUR

 Høkerlængen 2, Hyldespjældet DENMARK.	63 **Inhabitants** Around 1	**units.** **New highly insulated facade elements with 35 cm rockwool.** **Foundation Insulation with 40 cm foam.** **Mechanical ventilation with heat recovery. Natural ventilation through VELUX roof.** **Danfoss heat pump (soil, water).** **Air heating with additional heating in ground floor. District heating is switched off.** **Danfoss heat pump (soil, water).** **Velux 2.2 m2 solar collector and 10 m2 solar cells.** **Daylight, renewable energy, heat pump, mechanical ventilation with heat recovery.**		
	year of construction: 1976 **year of implementation of the ESM**: 2009		**Reduction in energy consumption:•**	Total refurbishment : - 112 kWh/m2/year (heating) - 24 kWh/m2/year (el)
 Fiskens Kvarter 1A–1F, Albertslund, DENMARK.	**Number of dwellings** 1 **Number of floors** 2 **Heated surface** After: 98m2/Before: 106m2 **Inhabitants** 21	**Roof : Insulation with 20-25 cm rockwool .** **New windows with 3-layer glazing units + skylights with automatic control.** **Ground floor: Insulation with 20-25 cm rockwool** **Façade: Isolation by 25 cm rockwool** **Natural ventilation.** **Danfoss low temperature district heating. Underfloor heating ground floor, radiators on the first floor.** **Danfoss heat regulation and control of VELUX skylight windows.**	**Investment & initial costs**	135 949 EUR
	year of construction: 1965 **year of implementation of the ESM:** 2011		**Heating energy consumption**	2010 : 13 992 kWh 2013 : 8 918 kWh
			% of energy reduction before/after the implementation of the ESM	2013 : - 37%

WP7: LOW-ENERGY BUILDINGS

This work package is specifically dedicated to the most recent constructions; low energy buildings built in the last 5 years, both individual and collective buildings. For the needs of the project, low energy buildings can be roughly defined as a building consuming less than 50 kWh of final energy /m2 of living surface1 for heating, ventilation and hot water.

The objective of this WP is to assess the environmental, economic and social performance of the operating management and the running maintenance implemented on recent low energy new constructions and, in a second time to elaborate optimization scenarios for these buildings through:

- A better prescription of the systems in the books of technical detailed specifications provided par the SHO in the call for tenders.

- Improvements notwithstanding from the point of view of the energy and economic performances point of view.

- Recommendations about the category of energy awareness measures to implement at the commissioning of the building.

It's a reality that some technical systems attached with Low Energy Buildings arise questions in the phase of operating management and maintenance. Two examples:

Compared with the global energy performance of the building, the double flux ventilation with heat recovery equipments consume a lot of energy and cost too much in terms of running maintenance (electricity costs, maintenance interventions for its regulation and its cleaning). This assumption is also valid for Low Energy retrofitting. There is a need for clear alternative regarding the ventilation as shown by the recent construction in U.S. of the first passive buildings with natural ventilation systems.

The metering in the recent Low Energy Buildings compared with the costs of the energy actually consumed by the inhabitants, the "traditional" way to invoice energy consumptions is obsolete. In many cases, the costs of the metering (maintenance of the meters + management of the invoicing) represent more than 50% of the energy costs paid by the tenants or the inhabitants. Is it justifiable?

SHO need a cost efficient Low Energy Housing easy to manage and easy to maintain. Otherwise there is a serious risk to slow down the new developments as it will impact too much the net cash flow of the SHO. AFTER integrates low energy new buildings because there is an important demand for feedback about previous experiences and an interesting potential of improvement of the performance, particularly in terms of energy. "There is a misconception that new buildings and recently renovated or retrofitted buildings no longer contain any significant energy-saving O&M opportunities"2. This potential is due to the lack of knowledge that often exists on the new techniques and systems implemented. It is also due to the fact that commissioning practices have often been reduced to very simple verifications.

Therefore, we estimate this potential at approximately 7,5% of the current energy consumption which corresponds roughly to half of the difference between the expected consumption (calculated in the design phase) and the real observed one after several heating seasons.

Low energy new buildings will be considered as a whole, as the impact of a technical element cannot easily be distinguished from another element especially regarding energy consumption. In this WP, an ESM will be a combination of the technical solutions regarding the shell (materials of the walls, of the insulation, of the windows) and the systems (heating, ventilation, hot water).

[1] Local variations to this rough definition will be accepted. For instance, a 55 kW/m^2 building in Denmark could enter into the scope of the survey.

[2] Operation and Maintenance Assessments, A Best Practice for Energy-Efficiency Building Operations, United States Energy Performance Agency / PECI, 1999

LOW-ENERGY BUILDINGS

ESM: RECENT LEBs / OVERVIEW

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Recent Low Energy Construction

INITIAL ISSUE RELATED TO THE ESM
Recently built low energy buildings are supposed to consume less energy than older structures. For this purpose, different concepts which may depend on various aspects like climate zone or budget or legal regulation, can be implemented. In this fact sheet, four examples from different countries are shown.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

There is **no global definition for low energy buildings.** Nevertheless –as a general definition- low energy building can be considered as any type of house that -from design to technologies and building equipment- uses less energy, from any source, than a traditional or average contemporary house.
Often passive or active solar design techniques and components are used to reduce the energy expenditure.

Benefits of low energy buildings are low energy consumption, low carbon dioxide emissions and low energy bills, an excellent indoor climate as well as high acoustical and visual comfort.
In fact, low energy buildings are known under many different names across Europe, e.g. Passivhaus, zero carbon house, energy saving house, high-performance house etc.

Although **various concepts for new low energy buildings exist**, they all base on the implementation of four basic components:

- **Well-insulated building envelops**
- **Energy-efficient windows**
- **Mechanical ventilation with heat recovery**
- **Efficiently run supply systems.**

As the needs for heating are reduced thanks to the high performance of the building envelope including doors and windows, **the efficiency of the ventilation (quality of the system and thermic impact, regulation of the air flow rates, etc.), the adjustment of the supply systems for heating and domestic hot water as well as the electric appliances gain a higher significance** and their optimization becomes more influential.

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

All new buildings need maintenance, operation and management. Activities and related costs may differ depending on e.g. the building concept or the country of implementation.
The high energy performance of the low energy buildings and its ambition imply important maintenance stakes. **Both the commissioning and the running maintenance are major aspects of the energy efficiency for LEBs**.

Commissionning activities are often too limited and it can lead to missing identification of disorders. Feedbacks on high energy performance often show that the systems and buildings characteristichs often do not correspond to the building notice and specification leading to a lag factor between the expected performance and the effective performance.
Maintenance is a major lever to optimize the energy savings in a LEB. Settings, regulation of the systems an balancing are necessary to guarantee the performance of a building and limit overconsumption or degradation of the building and its systems (failures, development of moisture, dirtying, etc.).

Another very important aspect and moment is **the transition between the construction partners and the future maintenance teams.** A good management concerning this task is very important in order to have a good information transmission regarding the characteristics and the instructions to obtain a good maintenance for the building and its systems.
The information is a quality requirement in new buildings with new systems and organization. More information means to strengthen the display of the instrucs but also to improve the communication with the subtrades and specialized teams that will work on the building (for example, the maintenance teams).

TENANTS' EMPOWERMENT ASPECTS

Inhabitants' behaviour and awareness do influence the energy consumption.
There are different activities possible that improve the awareness of the proper handling for a low energy building. The **inhabitants may be informed about the building concep**t e.g. by the use of a handbook or an information event. The interventions related to the four basic components are described in the a.m. extra factsheets.
The importance of the tenants' behaviors is a major aspect of LEBs. Due to **complexity of the systems**, **their interdependency** and the

exponential impact of potential disorders, these behaviors can imply consequences regarding both the energy consumptions and the losses and complaints. The intuitive and ergonomics characteristics of the systems and equipment is really important to make the use of the building easier for its inhabitants.
The information and the communication has to be consider and improved compared to more classic buildings (frequency, content of the information, quality and simplicity of the form notwithstaning with a more complex content, etc.).

TIPS AND ATTENTION POINTS

☑ MORE SYSTEMS, MORE PROBLEMS

Low energy buildings sometimes **accumulate the energy outputs of several supply systems for heating** (for example: renewable energy supply systems + other reserve system).
Due to this accumulation **the maintenance and the optimization of the systems are more difficult to manage and operate**. The reserve systems often provide a too higher help to the first supply system.

The **multiplication of the heating technology can induce some major problems regarding the replacement of the pieces and the maintenance interventions** (multiplication of the service providers, availability, competences, etc.).
As a consequence, a simple regulation has to be implemented in order to focus on efficient feedback and risk management.

☑ IMPROVE THE TRANSMISSION BETWEEN THE CONCEPTION TEAMS AND THE MAINTENANCE TEAMS

The **information exchange between all the actors of a LEB** is often a weak link that will impact the energy performance of the construction.
The **technical consultants** that have participated to the design and modelization of the building and its system must be implied in the post-construction phase. The **link between the technical consultants and the maintenance team** must be strengthen after the commissioning of the building in order to optimize the settings and the regulation of the systems (this work will also be useful regarding corrective aspects for the nexr projects).
The knowledge of the building and its expectations by the conceptors is useful in order to have a better control and to reach a better level of regulations that will be implemented by the maintenance team.

The **transmission of the information and documents** is really important to control.
The SHO can have an organisation and management role regarding this interface between the actors of the building. Meetings can be organized, team building interventions are necessary.

☑ OPTIMIZE THE DISPLAY OF THE INSTRUCTIONS

Descriptions and instructions regarding the functioning, the correct use and the expected objectives of systems must be displayed in the technical rooms of the building.
Necessary and optimal instructions must provide information regarding the technical scheme of the system or equipment, attention points and regulation, the functioning of the device, specifics regarding maintenance tasks (time range, attention points, etc.) and the like. Together with the implementation of a Building Management System (BMS) this **documentation** provides an essential support for the maintenance teams.

A **BMS** is a computer-based control system that monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems. It consists of software and hardware. The main parameters concerning the performance of the building systems (e.g. water temperature in the heating system, schedule of the working time for the ventilation system, etc.) are identified and can easily be compared with expected values. The **BMS is a good mean to monitor, control and correct the efficiency of a building**. It also allows cost and timesavings as problems get identified quickly and fewer visits on site are necessary.
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☑ SECURE THE MAINTENANCE CONTRACTS

As the maintenance is essential to guarantee the good performance of the LEBs.
The **maintenance has to be optimize**d and secured. The ambition is to:

- identify **relevant and well-qualified service providers for the maintenance** verifying their competences regarding LEBs and high energy performance equipments.
- try **not to multiplicate the service providers** in order to have a better overview and less interlocutors regarding the maintenance and the management of the building.
- limit the users involvement regarding the regulation of the systems with the help of a clear maintenance contract subscribed from the commissionning of the building with a service provider and describing precisely the different types of interventions needed to ensure the energy efficiency of the building.

☑ HELP TENANTS TO REACH A GOOD ENERGY EFFICIECY FOR THEIR DWELLINGS

In addition to the necessity to promote simple and ergonomic systems and equipment and to support the tenants behaviors with professional service providers, there is a need to **provide good information to the tenants about their buildings**.
One interesting option aims at **limiting the need of the tenants to operate on the systems of their building** and to prefer technicians interventions (for example on thermostatic valves regulation or the ventilation systems).
The other aspect is to provide good and simple information to the tenants. This family of «tips» is developed in the WP3 Factsheets.

DETAILED ASSESSMENT
Values extracted from a x sample of dwellings

SPEKTER poslovanje z nepremičninami  Savinjska cesta 9b, Trbovlje, SLOVENIA	**Number of dwellings** 13 **Number of floors** 5 **Heated surface** 786 **Inhabitants** 216	Building designed and built in accordance with old Slovenian national "Rules of Thermal Insulation and Efficient Energy Use in Buildings" - cf. Handbook. 10cm EPS shell insulation, min. 10cm EPS roof/ceiling insulation and 8cm EPS basement floor insulation. Double glazed windows. No heat recovery or ventilation systems.	Investment & initial costs/flat	891 829, 69 EUR
			Energy consumption for heating and domestic hot water (district heating)	2008 : 58.4 kWh/(m²a) 2009 : 56.8 kWh/(m²a) 2010 : 67.8 kWh/(m²a) 2011 : 61.8 kWh/(m²a) 2012 : 50.3 kWh/(m²a) 2013 :49.1 kWh/(m²a)
	Year of construction: 2006		Energy costs for heating	2008 : 3.58 EUR/(m²a) 2009 : 3.77 EUR(m²a) 2010 : 3.74 EUR/(m²a)
			Maintenance and management consumptions	not provided by the SHO
AARHUS KOMMUNE  Langballevej 9A-9H, Mårslet, DENMARK	**Number of dwellings** 8 **Number of floors** 1 **Heated surface** 566 **Inhabitants** 8 to 16	Terraced houses for elderly people. Low energy Kl.1 according to danish BR98. Insulation 445mm / Roof, Insulation 200mm / Walls, Insulation 300mm / Foundation, Windows & Frames / Insulation, Windows & Frames (U=1,20 w/m2*k incl. frame and sash) / Sun Protection, Photovoltaics (Solar panels on the roof 7.66 per m2. house (0.154 kW/m2 Peak power and system efficiency of 0.752), Ventilation and heat recovery & District heating. Energy carriers: 2013 Approx. 40% biomass (mainly straw and domestic waste) and 60% coal	Investment & initial costs	1 808 500, 00 EUR
			Energy consumption for heating and hot water (district heating)	2011: 82 kWh/m²a 2012: 114 kWh/m²a
	Year of construction: 2011		Costs for heating and hot water energy consumption (district heating)	2011: 8.35. EUR/m²a 2012: 8.67. EUR/m²a
			Costs for maintenance, operation and management	2011: 143.21 EUR/m²a 2012: 145.87 EUR/m²a
bauverein AG darmstadt  Elisabeth-Selbert-Straße 6-8, Darmstadt, GERMANY	**Number of dwellings** 44 **Number of floors** 4 **Heated surface** 4144 **Inhabitants** 90	Passive house standard planned in PHPP with a Insulation of the facade with 30 cm EPS, double flow ventilation system and triple Heat protection Glass. District heating system. Electric warm water tank. Energy consumption: Final Energy: 43 kWh/m2.a Primary Energy: 119 kWh/m2a	Investment & initial costs/flat	5 896 000 EUR
			Energy consumption for heating and hot water	2011 : 37.6 kWh/(m²a) 2012 : 40.9 kWh(m²a) 2013 : 40.8 kWh/(m²a)
			Costs for heating and DHW energy consumption (district heating)	2011 : .4.83EUR/(m²a) 2012 : 5.84 EUR/(m²a) 2013 : 5.12 EUR/(m²a)
	Year of construction: 201		Costs for maintenance, operation and management	2011: 3,76 EUR/m²a

 **2 rue Camille Guérin, Bétheny, FRANCE**	**Number of dwellings** 13 **Number of floors** 4 **Heated surface** 1538 **Inhabitants** 30	**External thermal insulation of 30cm.** **Ground-coupled heat exchanger.** **Double-flux ventilation.** **DHW with solar panels.** **Green roof.** **Triple-glazing south. Double-glazing for the rest of the building .**	**Investment & initial costs/flat**	1 963 684 EUR
			Energy consumption for heating and hot water, electricity and auxiliaries	2011: 87 kWh/(m2.a) HDD: 2567 2012: 73,43 kWh/(m2.a) HDD: 2455 2013: 93,58 kW/(m2.a) HDD: 2789
	Year of construction: 2009		**Costs for maintenance, operation and management**	Ground-coupled heat exchanger: 200EUR/year Ventilation: 1700EUR/year Solar DHW : 1370EUR/year

LOW-ENERGY BUILDINGS

ESM: RECENT LEBS / INSULATION

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Recent Low Energy Construction

INITIAL ISSUE RELATED TO THE ESM
In existing buildings, transmission heat losses through the building envelope account for the largest share of total heat losses. Therefore, improving the energy quality of the building envelope is the most effective way to save energy.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

A **continuousinsulated envelope all around the building minimizes heat losses** through the conduction of heat through the building fabric.
In this context it is also **essential to avoid or at least minimize thermal bridges**. In addition to the insulating envelope, there should also be **an airtight layer to prevent heat losses and damages through exfiltration**.
The most common way to meet these requirements is **to install external insulation layers**. Using a pencil it should be possible to outline the minimum insulation thickness of the whole external envelope in the building sections and floor plans within the insulation layers without a break.

Low energy and Passive houses need **construction components with little heat losses reflected in very good U-values**.
The U-value (Watt per m² and Kelvin) reflects the energy loss of a particular construction component. The lower the U-value, the better the insulation. Requirements differ depending on the location of the building (climate zone, national requirements) or the intended building standard.

THERMAL BRIDGES
It is important that the insulation is, as far as possible, "undisturbed", crack-free and without any kind of penetration, joints and draughts. Special attention has to be drawn to potential thermal bridges that are defined as areas of the building envelope (e.g. junctions between building components) where the heat flow is different (usually higher) in adjacent areas

For well-insulated envelopes and buildings with increased energy efficiency, the ratio between the thermal bridging effect and the overall thermal losses increases compared to low or medium insulated buildings. Therefore, the **influence of thermal bridging on the energy consumption is of major importance**.

AIR TIGHTNESS
In addition to the insulating envelope, there should also be an airtight layer. **Uncontrolled air ex-filtration and air leakage through cracks and joints in the building envelope cause unnecessary heat consumption and put the construction at risk of moist and mould**.
Leaks allow warm moist air to flow from the inside to the outside, cool down, leave condensed water behind and thus cause mould and rot. Apart from that, **the airtight envelope is an indispensible must** for all buildings with mechanical ventilation with heat recovery, as air that escapes via cracks is lost for the process of heat recovery.
Air tightness in buildings is defined by an n_{50}-test measurement which combines both under and over pressurization tests.
Complementary to the airtight layer, the construction should be permanently wind tight on the exterior to avoid the infiltration of air and moisture from the outside.

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

During or after the construction phase of a building **defects in the building envelope can be found with equipment such as blower doors**, which measure the extend of leaks in the building envelope, and infrared cameras, which reveal hard-to-detect areas of missing insulation and air flows:

BLOWER DOOR TEST
The blower door consists of **a compressor built into an opening (e.g. a door) creating negative pressure inside the building in order to detect leakages**. The higher outside air pressure then flows in through all unsealed cracks and openings. The auditors may use a smoke pencil to detect air leaks.
The actual test involves a series of negative and positive pressure measurements determining the leakage rate at a differential pressure of 50 Pa in relation to the overall building volume (n50 value).

THERMOGRAPHIC INSPECTIONS
Thermal defects and air leakage in building envelopes can be detected by infrared scanning, also known as thermography.
Thermography measures surface temperatures by using infrared cameras. These tools visualize light that is in the heat spectrum. The resulting images, also called thermograms, therefore record the temperature variations of the building's skin. That way a competent

auditor can determine whether the insulation has been installed correctly.
Thermographic scans are also commonly used with a blower door test running. The blower door helps exaggerate air leaking through defects in the building shell. Such air leaks appear as black streaks in the infrared camera's viewfinder.

Blower door test and thermographic inspection should be carried out in order to safeguard warranties and also for retro commissioning reasons.

TIPS AND ATTENTION POINTS

☑ IMPROVE THE AIRTHICKNESS OF THE BUILDING WORKING ON THE INSULATION DETAILS

Some parts of the insulation will have to be particularly focused on. **Solutions regarding details can be identified to intervene on these weak points of the envelope**.
All the different points can't be detailed here as they depend on the type of the structure and as they cover numerous points of the building.

The French Project MININFIL has been promoted by the French Minister of sustainable development and by the French energy agency ADEME. The project collects an exhaustive number of details and attention points that will be very useful to realize a well insulated shell.
The project gathers **5 guides with details for 4 types of constructions**: internal insulation, external insulation, wood-frame, and brick or AAC than can be consulted here:

http://enqueteur.cete-lyon.developpement-durable.gouv.fr/index.php?sid=57643

A **special attention** has to be carried out on openings of the building that can lead to air leaks:

- **doors between heated and unheated spaces** and rooms of the building.
- **interfaces between the shell and the carpentries**.
- **smoke dampers**.
- **glazing bead**.
- **rolling shutter casings**
- etc.

All these examples are detailed with schemes in the MININFIL guide.

☑ PREVENT THE PERFORATION OF THE SHELL BY THE NETWORKS

All the **circulation of networks through the envelope of the building can provocke air losings**.
A first solution is to limit them trying to let the networks circulate indoor. Electric ducts or the plumbing tubes and pipes have not to circulate within the shell as they can perforate the air thickness membrane. A unenclosed space (vertical chase) must be created between the insulation and the membrane in order to obtain a circulation of the networks.

☑ BE CAREFUL REGARDING THE VACUUM SPACE BETWEEN INSULATION PANELS

The **vacuum between the insulation panels can provocke a fresh air circulation in the air gap created leading to a reduction of the insulation performance**. The contact between the insulation panels have to be checked and cutting machines have to be adapted to the characteristics of the insulation material in order to permit a precise cutting.

☑ PROTECT THE INSULATION PANELS

The protection of the insulation material before the construction is really important in order to guarantee its efficiency.
Degradations during their transport or the work area (thermal expansion due to an exposure to the sun, humid panels due to a rain exposure of the insulation panels) can be responsible of important malfunctions creating a gap with the expected performance of the LEB.
As a consequence, **a good protection of this material has to be implemented both during their transfer, their storage and their laying** (coverage, reduction of the covering period, special space to protect from sun and rain, protection of the facades against weather condtions before the final cladding).

☑ INFORM THE SUPPLY PROVIDERS ABOUT THE AIR THICKNESS PLAN

The **information of the construction partners regarding the air thickness plans and attention points** in the building is really important. As the performance of the envelope is a crucial point for the energy performance of the building, the quality of its treatment during the construction is important. Construction actors have to be adviced about the responsibilities of every involved partners, control points have to be implemented in order to check that materials implemented are corresponding to the ones pallned in the modelling of the building, prevention of additional borings during the construction phase, etc.

☑ PREVENT THE POST-COMMISSIONING INTERVENTIONS ON THE SHELL

Holes and breakings in the walls after the construction (tenants) can lead to air infiltrations in a high performance insulation.
In order to avoid this risk, the SHO will have to be careful in informing the tenants about the potential damages created by interventions on the shell thanks to a special information (cf. WP3 Factsheets).

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

 **Savinjska cesta 9b, Trbovlje, SLOVENIA**	**Number of dwellings** 13 **Number of floors** 5 **Heated surface** 786 **Inhabitants** 38 **Year of construction:** 2006	**Base slab** Parquet/ceramics 1cm - Screed 6cm EPS 8cm - Concrete 10cm U = 0,378 W/m²K **Basement ceiling** Parquet/ceramics 1cm - Screed 4cm EPS 2cm - Concrete 14cm - Insulation panels 8cm - Mortar 2,5cm U = 0,481 W/m²K **Exterior Walls** Mortar 2,5cm - Concrete 20cm - EPS 10cm - Final façade U = 0,317 W/m2K **Upper floor ceiling** Mortar 2,5cm - Concrete 14cm - EPS 10cm - Screed 5cm U = 0,311 W/m2K **Roof** Gypsum plaster panels 1,5cm - EPS (6+12) 18cm - Roofing U = 0,192 W/m2K	**Cost of the investment**	38.000 EUR Approximate evaluation of costs of the thermal envelope was made using building's project documentation calculations data. The actual costs could differ.
			Have performance indicators for thermal bridges been calculated?	no
			Has a blower door test been realized?	no
 **Langballevej 9A-9H, Mårslet, DENMARK**	**Number of dwellings** 8 **Number of floors** 1 **Heated surface** 623 **Inhabitants** 8 to 16 **Year of construction:** 2011	**Base slab** 100mm concrete 330mm polystyrene U = 0,11 W/m²K **Exterior Walls** Aerated concrete panels 100mm - Insulation/steel structure 245mm - Breather paper 4mm - Steel structure 25mm - Fibre cement board 6mm U = 0,18 W/m2K **Roof** Insulation 250mm - Insulation/bottom chord 150mm - Damp-proof membrane - insulation/batten 45mm Plasterboard ceiling on spread lining boards	**Cost of the investment**	Exterior walls: 226.001,00 EUR Base slab: 39.180,00 EUR Roofing: 154.030,00 EUR Closing: 72.310,00 EUR
			Have performance indicators for thermal bridges been calculated?	Yes Psi-values or correction factor Linear loss at foundation: 0,13 W/mK Linear loss at windows and doors: 0,02 W/mK Linear loss at skylight: 0,06 W/mK Linear loss at unheated foundation: 0,13 W/mK Linear loss at window seam: 0,02 W/mK
			Has a blower door test been realized?	Yes n50-value Average at 50 pascals: 1,22 l/s/m²

bauverein AG darmstadt  **Elisabeth-Selbert-Straße 6-8, Darmstadt, GERMANY**	**Number of dwellings** 44 **Number of floors** 4 **Heated surface** 3457 **Inhabitants** 90	**Base slab** Screed 50 mm - Sound insulation 30 mm Insulation 220 mm - Concrete 300 mm - Foam glass gravel 150 mm U = 0.12 W/m²K **Cellar ceiling** Screed 50 mm - Sound insulation 30 mm Insulation 220 mm - Concrete 220 mm U = 0.13 W/m²K **Exterior walls / external wall insulation system** Masonry 175 mm - Insulation (polystyrene) 300 mm U = 0.11 W/m²K **Roof** Plasterboard 12 mm - Insulation / Lath (10 %) 140 mm - Damp-proof membrane Insulation / Rafter (10 %) 280 mm - Oriented strand boards 16 mm U = 0.10 W/m²K	**Cost of the investment**	862 000 EUR
			Have performance indicators for thermal bridges been calculated?	Yes, part of the certification by PHI
	Year of construction: 2010		**Has a blower door test been realized?**	Yes n50-value Average at 50 pascals: 0,6 h-1
Foyer Rémois  **2 rue Camille Guérin, Bétheny, FRANCE**	**Number of dwellings** 13 **Number of floors** 4 **Heated surface** 1538 **Inhabitants** 30	**Exterior walls / external wall insulation system** Concrete structure = 200 mm Neopor ® polystyrene with graphite additive: 300 mm Λ=0,032 W/m.k **Roof** Insulation: 240mm polyurethane foam + green roof with a 50cm cover. **Ground floor** 60mm polyurethane foam 200mm mineral wool	**Cost of the investment**	Exterior walls: 78 824,41 EUR Basement floor: 15 191,99 EUR Roofing: 33 838, 73 EUR Base: 9 129, 93 EUR
			Have performance indicators for thermal bridges been calculated?	Yes, part of the certification by PHI
	Year of construction: 2010		**Has a blower door test been realized?**	Yes n50-value Average at 50 pascals: 0,46h-1

LOW-ENERGY BUILDINGS

ESM: RECENT LEBS / WINDOWS

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Recent Low Energy Construction

INITIAL ISSUE RELATED TO THE ESM
Reducing transmission heat losses and increasing solar gains through the installation of energy efficient windows.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

As far as the thermal losses of the building envelope are concerned, **windows are still a weak spot**.

Windows are often responsible for approximately 10 to 15% of the heating losings for a building.
It is therefore **important to install windows with low U-values** (overall heat transfer co-efficient).
U-values of windows (Uw) depend on **the U-value of the frame (Uf), the U-value of the glazing (Ug), the size of the window and thermal bridges at the edge of the glazing**. Criteria for Passive Houses additionally consider **the U-value of the installed window (Uw,installed).**

For Passive Houses in Mid-Europe triple glazed windows with insulated frames are essential.
For other low energy concepts and/or in other climate zones, double glazed windows might be sufficient. Triple-glazing is advantageous because of its very good thermal insulation. It also guarantees a good thermal comfort during the summer.
{**Ug-Value for triple glazing is between 0,8 - argon gas filling - and 1 - air gas filling**}.

Apart from the avoidance of thermal losses, a high share of solar gains during the heating period is aimed at. An indicator for the solar gain transmittance of a window is the g-value. Values range from zero to one whereby lower values represent lower solar gains. Whereas solar gains are wanted during the heating period, in summer it is relevant **to avoid overheating**. This is usually done by **a combination of shading during the day and ventilation during the night**.
The triple glazing reduces the heating absorption potential for a window as it implies a low uptake of the warmth of the sun rays.

This characteristic implies that triple-glazing is very efficient in improving the thermal comfort during the summer but will allow littler captures for the natural warmth during the winter. It will also have an impact on the light diffusion in the house. As a consequence, triple glazing will be more efficient on the north-oriented parts of a building as it will garantee a good control of the heating losings than on the south-oriented facade were it will reduce the solar gains.
As **the triple glazing is significantly more expensive than the double glazing a good combination of these types of windows depending on the orientation of the building has to be implemented**.

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

As the **triple glazing is heavier than the simple and double glazing**, a special attention has to be carried out regarding the evolution of the frame and should be inspected regularly with regard to air tightness and the and treated or repainted as required.

Solar gains are particularly important in a low energy building, the cleanliness of the windows (especially regarding triple-glazing windows that allow a smaller heat absorption of the solar gains) can improve its energy efficiency and the comfort resulting from more daylight.

Different kinds of windows have different symptoms; therefore all inspections must be tailored to the type of window.
In general:

- **Frames should be inspected regularly** and treated or repainted as required.
- **Attention should be paid to water stains, rot and other indications that moisture has been reaching the interior**.
- **The fit of windows should be checked**. Frames and sashes are subject to changes in size with use and exposure to temperature cycles. As a result, a gap can form between window component, increasing both air and water infiltration. Because of the higher weight, especially the fit of triple glazed windows should be inspected regularly with regard to air tightness.
- **The caulking between the frame and the building wall should be examined**. With time and exposure to light, moisture and temperature extremes, the seals can lose flexibility and fail.

TENANTS' EMPOWERMENT ASPECTS

A frequent concern is that users of low energy buildings with ventilations systems are not allowed to open their windows.

Of course, **opening the windows in winter increases the heat losses** and also the heating demand of a house if the heating is in operation - just like in any conventional / old building. But **in almost all cases these additional losses are insignificant**. In general, it is therefore no problem to open the windows in low energy buildings

.

When there are high outdoor temperatures in summer it is even recommended to open the windows during the night to reach a high level of air exchange and thus a natural cooling.
Another important aspect to avoid overheating in summer is appropriate shading during the day. Shading in winter however, is detrimental to the use of solar gains and should be avoided.

Inhabitants of low energy buildings need this information and advice when moving in. Information needs to be repeatedly given and in a very straight and strait forward form.

Whereas **shading in summer is advisable to avoid overheating, shading in winter is detrimental to the use of solar gains**. A modification or a hindrance regarding the solar exposure surface can have important consequences and create a disconnection between the reality and the modelized solar gain and the real use of the building having an impact on the energy consumptions for both heating and lightning consumptions.

In order to guarantee a good use of the windows, inhabitants need the respective information and advise when moving in. Information need to be repeatedly given and in a very short and strait forward form detailing the potential disorders that can impact the performance of the glazing.

TIPS AND ATTENTION POINTS

☑ CONTROL THE AIRTIGHTNESS AT THE INTERFACES OF THE WINDOWS THANKS TO A BETTER KNOWLEDGE OF THE CONCEPTION DETAILS

As windows are a part of the building envelope, attention has to be paid to planning, detailing, execution of construction word, and quality assurance as described in the fact sheet "Recent LEBs / Building Envelope".

Low emissivity coating (Low-E coating) is typically used on one inner surface of a double or triple glazing unit.
This Low-E coating on one hand **allows short wave radiation, from the high temperature sun to pass in through the glass**. On the other hand, it **restricts the amount of long wave radiation**, from the lower temperatured room, passing out through the glass. It has however made to be sure that the coating is installed on the right glazing surface. A visual test can be implemented during the construction phase to check if the windows have been correctly installed.

A special work has to be provided regarding the insulation at the edge of the entrance doors and the bay and picture windows in order to reduce linear thermal bridges (thermal bridge at the interface between 2 partitions). An attention has to be carried out regarding the description of the details regarding the conception principles and the critical steps.
The project MININFIL carried out in the PREBAT program by the French Sustainable Development Ministère an the French Energy Agency presents a large collection of drafts recommendations to guarantee airtightness 4 types of constructions: internal insulation, external insulation, wood-frame, and brick or AAC.

http://www.cete-lyon.developpement-durable.gouv.fr/carnets-prebat-mininfil-r105.html

☑ ANTICIPATE THE USES OF ALL THE TENANTS

The weight of triple-glazing windows and entrance doors has to be considered regarding the quality of their use for the tenants (especially for special categories of tenants such as ederly people, disabled persons, etc.).

Some **attentions points** can reduce this risk:

- prequesited test of the opening before the construction in accordance to the future tenants and the regulations regarding the general accessibility of the building.
- promotion of more fragmented surfaces of opening during the conception of the building.
- possibility to motorize the entrance doors as a corrective solution.

☑ ANTICIPATE AND CORRECTING THE IMPACT OF UNEXPECTED SOLAR MASKS

The **possible reduction of the energy for solar lightning (solar masks implemented by the tenants, closed shutters, etc.) has to be anticipated and corrected**:

- thanks to a special effort regarding the awareness of the tenants: distribution of information, coachig, etc...
- thanks to the rules and regulations in application on the housing stock of the concerned SHO (banned unauthorized and additional fences or vegetal screens, etc.).
- thanks to better attention and anticipation of these unexpected interfereces during the conception phase.

☑ IDENTIFY WRONG POTENTIAL WRONG INSTALLATIONS

Some disorders and unefficient savings have been identified due to a «back to front» installation of double or triple glazed windows: a preventive visual test can be implemented during the construction phase to check if the windows have been correctly installed.

☑ AVOID COUNTERPRODUCTIVE OR UNEFFICIENT SUNSHADING

The **permanent sunshading structures can be a cause for potential disorders**: difficulties regarding the maintenance and the cleaning of windows (with a diminution of the solar gains due to the dirtying of the glazing), deterioration by tenants, etc. As a consequence, they need to be designed with a particular attention during the conception phase in order to garantee both their durability and to not block the maintenance of the glazing surfaces.
They may also be presented to the tenants during the awareness campaign.

* Automated exterior blinds are sometimes used in order to control the shading of the buildings regarding the solar gains.
These mechanical blinds can link highly performant windows with a shading system negative regarding the uses of the tenants: constant open/closing some days when the solar gains are more variable and inconstant, lack of independence of the tenant on the use of the system).
As a consequence, these kind of mechanical systems have to be associated with good and flexible parameters that can garantee quality comfort for the tenants and avoid complaints or deteriorations. Tenants may also have the ability to self-control the opening of the blinds when needed.

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

SPEKTER poslovanje z nepremičninami  **Savinjska cesta 9b, Trbovlje, SLOVENIA**	**Number of dwellings** 13 **Number of floors** 5 **Heated surface** 786 **Inhabitants** 38	**Kind of window** Double glazing, gas filling, PVC frame **Average U-value window installed (Uw,installed)** Unknown **Average U-value window (Uw)** ~1,3 W/m2K **U-value frame Uf** ~1,2 W/m2K **U-value glazing Ug** ~1,1 W/m2K **g-value** Unknown	**Cost of the investment**	25.000 EUR Approximate evaluation of costs of windows was made using building's project documentation calculations data. The actual costs could differ.
	Year of construction: 2006		**Installed measures to avoid overheating in summer**	no
AARHUS KOMMUNE	**Number of dwellings** 8 **Number of floors** 1 **Heated surface**	**Kind of window** 3 (triple) layer glazing, Gas filling: Argon, Aluminium and wood frame **Average U-value window installed (Uw,installed)**	**Cost of the investment**	72.307,00 EUR

 Langballevej 9A-9H, Mårslet, DENMARK	623 **Inhabitants** 8 to 16	**Not available** **Average U-value window (Uw)** **1,2 W/m2K** **U-value frame Uf** **Not available** **U-value glazing Ug** **0,80 W/m2K average** **g-value** **0,51 average**		
	Year of construction: 2011		**Installed measures to avoid overheating in summer**	Only passive protection. Roof overhang and G-value in glazing
bauverein AG darmstadt  Elisabeth-Selbert-Straße 6-8, Darmstadt, GERMANY	**Number of dwellings** 44 **Number of floors** 4 **Heated surface** 3457 **Inhabitants** 90	**Kind of window** **Triple-glazing** **Average U-value window installed ($U_{w,installed}$)** **0.79 W/m2K** **Average U-value window (U_w)** **Unknown** **U-value frame U_f** **0.74 W/m^{2}K** **U-value glazing U_g** **0.60 W/m^{2}K** **g-value** **0.47 (average value)**	**Cost of the investment**	433 000 EUR
	Year of construction: 2010		**Installed measures to avoid overheating in summer**	Yes, shutters in the north, east and west. Binds at south.
Foyer Rémois  2 rue Camille Guérin, Bétheny, FRANCE	**Number of dwellings** 13 **Number of floors** 4 **Heated surface** 1538 **Inhabitants** 30	**South-East-West: double glazing (argon) 4/16/4 mm with aluminium frames.** **North: triple glazing 4/12/4/12/4 mm with wood frames.** **Average U-value window installed ($U_{w,installed}$)** **1,00W/m2K** **U-value glazing U_g** **0.80W/m^{2}K** **g-value** **0.6**	**Cost of the investment**	272 800, 74 EUR
	Year of construction: 2010		**Installed measures to avoid overheating in summer**	Sun screen with slats on the south face but the glazing surface is to important.

LOW-ENERGY BUILDINGS

ESM: RECENT LEBS / VENTILATION

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Recent Low Energy Construction

INITIAL ISSUE RELATED TO THE ESM
Sufficient ventilation, clean and fresh air is a basic requirement and a perception of hygienic and comfortable living. Very airtight buildings seem to be in contradiction to these expectations. In an airtight building it is very important to ventilate regularly as moist air from kitchen, bathroom and toilet will not vacate the building through thermal bridges or cracks or other bypass routes. Ventilation by opening windows of course is possible however most of the heat contained in the indoor air leaving the building is lost. In order to recover ventilation heat losses mechanical ventilation with heat recovery is needed.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

A **heat recovery system recovers the heat from the exhaust air and - using a heat exchanger - transfers it back into the supply air without mixing the air flows**. Warm moist indoor air is extracted from kitchen, bathroom and toilet. This air is channelled through a heat exchanger which delivers up to 80 – 90 % of the heat to the incoming fresh air. The two air streams, i.e. the incoming and the exhaust air remain separate and do not mix during this exchange process. The fresh air gets pre-warmed in the heat exchanger and then is distributed to all living rooms. Depending on the efficiency of the heat exchanger, over 90 % of the heat from the exhaust air can be passed on, which brings the incoming air almost up to room temperature.
The ventilation system should not be noticed and thus the supply and exhaust air ducts need to be fitted with silencers that prevent sound transmission between the rooms – the Passive House maximum sound level is 25 dB (A).
Heat recovery efficiency should be ↗ 75 %, i.e. recovering that percentage of heat from the outgoing warm air. The ratio of needed electricity to recover the heat should be 1:9 in order to recover running costs by the saved energy.

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

For easy operation of the ventilation with heat recovery some aspects need to be regarded:

• The **high quality filters** (fresh air inlet and coarse filters for the exhaust air) need a regular cleaning and an annual replacement of the outside filters. **Filters must be clean as plugged filters don't carry air but consume electricity**. The ventilating fans need cleaning.
• **Regular check up and monitoring of the proper functioning** of the heat recovery ventilation system.
• Right after installation of the heat recovery system **the supply air and exhaust air quantities need to be precisely set**.
• A **well arranged and easy to read operation device** supports the proper operation of the heat recovery system.
• A **maintenance contract agreed upon** with skilled and specialized companies is recommended.

Access for maintenance and repairs is very important since the filters in a mechanical ventilation unit need to be replaced at least twice a year. Usually this means access of at least a metre to the front of the unit. One particularly neat solution is to build a plant room that can be accessed from the outside so the tenants do not need to be in when the contractor comes to replace the filters. The room should still be located within the thermal envelope so the ventilation unit doesn't need to be insulated. The room should be built in block work so there is no noise pollution to the rest of the house.
Because of the maintenance requirement the loft space is not considered and ideal location for the main unit. If possible, space should be found in a ground floor location.

TENANTS' EMPOWERMENT ASPECTS

Inhabitants should be instructed on the proper use of the ventilation system in a continuous and easy form.

Written and oral information should be combined. Handbooks or flyers addressing the specific aspect are advisable. Ventilation by opening the windows need a special emphasis and awareness raising .

TIPS AND ATTENTION POINTS

☑ IDENTIFY THE ERRORS BEFORE THE STARTING OF THE SYSTEM

Some errors can occured during the installation of the MCVHR system (for example a system installed bottom-up). In order to prevent these risks, **SHOs have to be sure that the system has been installed in accordance with the design part of the suppliers instructions**.
Tests before the commissioning can be implemented in order to identify and correct potential disorders.

☑ FOCUS ON A GOOD ACCESS FOR THE MAINTENANCE AND REPAIR OF THE MCV WITH A SPECIAL ROOM

S**ome systems are very difficult to access (located in the attic spaces, etc.) as a consequence their maintenance is more difficult** leading to disorders and deterioration of the Indoor Air Quality.

As a consequence, **the MCV system has to be positioned in a inside, accessible and adapted room** (positioning the ventilation unity outside of the heated space will cause severe thermic losings for exemple). **This room will have to be large enough to make the maintenance and the interventions easier**. In the room, systems will have to be accessible (not to close from the walls or hidden by some cables for example), The room also has to be at the same temperature as the indoor air in order to avoid risks of condensation.
The ventilation unity may also be disunite with the walls of the building in order not to create a vibration due to running the heat exchanger motor.

☑ ENSURE A COMFORTABLE SPACE FOR THE TENANTS

MCVHR installation can reduce the space of the dwellings (for example reducing the distance between the floor and the ceiling due to the circulation of the ventilation networks).
The SHO may be sure that the future circulation of ventilation ducts has been identified during the general design of the builings and its floors.
This network has to be designed integrating the uses of the tenants, the diameter of the ventilation ducts may be reduced (using double or triple ducts).

☑ MONITORE AND FOLLOW THE FUNCTIONING OF THE TENANTS

Problems regarding the proper functioning of the ventilation system can lead quickly to major issues such as the development of moisture. These problems can be the result of safety modes activation or also the result of tenants' behavior (closed air vent for example).
In order to identify and to act rapidly, **a following and monitoring complementary system can be set up with some visual visits or automated control systems** (for example automated decentralized alarm systems) in order to follow the fuctioning of the ventilation system.

The maintenance of the MCVHR systems is really important to ensure the good functioning of the system and the comfort of the tenants. **Cleaning and changing of the filters (every 4 months) is a major stake to guaranty the durability of the system. The flow capacity of the ventilation can be reduced from 75% in 9 months without a renewal of the filters**.
In order to make this maintenance easier, clear maintenance contracts have to be done with service providers and the tenants (or caretakers) must be informed about the necessity to clean the system and how to do it.

☑ BE AWARE OF THE GOOD POSITIONING OF THE SYSTEM ELEMENTS

All the elements of the ventilation have to be well located and installed in the dwelling in order to reduce the thermic losings and to improve the comfort of the tenants.

The lenght of the ducts has to be optimized in order to reduce the distance between the heat exchanger and air intake/outake. Rhis attention point will help to avoid to preheat the circulating air before its circulation in the heat exchanger, or before to be rejected.

Positioning of the air vents can generate discomfort for the tenants (sensation of air circulation, noise, etc.). There is a risk to see the tenants acting by themselves to solve these problems, degrading the system.
As a consequence, air vents have to be positioned in spaces where they can't disturb the tenants' uses.

In order to reduce the sensation of air circulation, the system has to be respect a good air velocity in m/s (please find more information about it below).
In order to guarantee the good air renewal, the air vents may be positioned close to the ceiling (Coanda effect) and **doors may be undercutted in order to enhance the air circulation** (must be controled during the construction phase and at the commissionning).
In order to guarantee an efficient air renewal extraction and insuflation vents must be correctly positionned in order to create a good air circulation.

☑ CONCEIVE THE INSTALLATION IN ORDER TO OBTAIN EFFICIENT AIR FLOW RATES AND BALANCING THE DISTRIBUTION NETWORKS

The conception of the network has to focus on a good balancing of the system with a central ventilation unity in order to avoid too important flow rates in some parts of the dwelling.
These flow rates must obey the reglementation or to exceed it. The respect of these flow rates can be included in the contracts with the supplier, in order to control that the system and its implementation will be correctly installed and tuned.
Before the commissioning, **regulation and testing process has to be**

done. Extracted and insuffled air flow rates have to be equal in order to avoiding to have the uncontrolled air leakage out of the building. **This attention regarding the air flow rates is also really important regarding comfort aspects for the tenants**. Comfort is define by the temperature, the humidity and the air speed sensation. Good flow rates are useful to reduce the humidity of the indoor air and to provide a peaceful sensation to the tenants. **This thermal comfort will reduce the risk to see the tenants raising the heating temperature level**, focusing on the temperature as the reason for their discomfort.

☑ MONITOR AND FOLLOW THE FUNCTIONING OF THE TENANTS

In order to quickly detect and identify failures of the system, **monitoring devices with automatic control systems can be installed**.
Some units provide onboard diagnostics that are supposed to ensure that the event of a fault is reported and quick identification is possible. They also **provide a message on the integral display when the filters need changing**.

In order to make this maintenance easier, clear contracts have to be concluded with service providers and **the tenants (or caretakers) must be informed about the necessity to clean the system and how to do it**.

☑ DRY AIR ISSUES

The air in a Passive House is generally drier than the air in a house with poorer ventilation; and generally this is a good thing.
Excess moisture in homes has a direct link to the growths of moulds, the flourishing of dust mites, and the presence of unpleasant pests such as silverfish, clothes moths, and woodworm.
Excessive dampness indoors can harm the health of the occupants, the fabric of the building, the furniture and the contents.
A comfortable and healthy range for relative humidity is usually between 35 % and 60 %. Measured results from quality assured Passive House buildings show that the average relative humidity remains within this threshold of comfort.
In general, if you are adequately heating and ventilating a building, but indoor moisture production is low, the indoor air In any building (not only a Passive House) may get to dry.

Building occupants who find that their sinuses, or eyes, get a little dry in very cold whether have a number of choices that could be used to address this discomfort, e.g. watering the house plants, using atomisers, temporarily reduce the ventilation rate or using vaporisers (which require electricity for operation and therefore result in higher carbon emissions, and have filters that should be regularly cleaned).

DETAILED ASSESSMENT

Values extracted from a x sample of dwellings

SPEKTER poslovanje z nepremičninami  Savinjska cesta 9b, Trbovlje, SLOVENIA	**Number of dwellings** 13 **Number of floors** 5 **Heated surface** 786 **Inhabitants** 38 **Year of construction:** 2006	Natural ventilation through windows No mechanical system installed		
AARHUS KOMMUNE  Langballevej 9A-9H, Mårslet, DENMARK	**Number of dwellings** 8 **Number of floors** 1 **Heated surface** 623 **Inhabitants** 8 to 16 **Year of construction:** 2011	Individual central unit with cross-flow heat exchanger and automatic by-pass. NILAN Comfort 250® ventilations unit, with NILAN CTS602® control unit	**Cost of the investment**	28.082,00 EUR
			MVHR Heat recovery efficiency	92%
			MVHR Electrical efficiency	Max: 1,05 [kJ/m3] = 0,291 [Wh/m3]
			Maximum sound from MVHR unit	30 [dB(A)]
bauverein AG darmstadt  Elisabeth-Selbert-Straße 6-8, Darmstadt, GERMANY	**Number of dwellings** 44 **Number of floors** 4 **Heated surface** 3457 **Inhabitants** 90 **Year of construction:** 2010	Double flow Controlled Mechanical Ventilation system with Heat recovery). Local, decentral system, one ventilation system per dwelling. Vallox 90 SE + control unit for air handling units LUFTÄ LSG-16B	**Cost of the investment**	242 000 EUR
			MVHR Heat recovery efficiency	80%
			MVHR Electrical efficiency	0,44Wh/m3
			Maximum sound from MVHR unit	35dB

 2 rue Camille Guérin, Bétheny, FRANCE	**Number of dwellings** 13 **Number of floors** 4 **Heated surface** 1538 **Inhabitants** 30	**Double-flux ventilation with individual place heat recovery exchanger ALDES Dee-Fly 300 Micro-Watt** **+ coupled with a ground coupled heat exchanger buried at 2,5m under the building with a bypass option.**	**Cost of the investment**	93 952, 38 EUR
			MVHR Heat recovery efficiency	90%
			MVHR Electrical efficiency	0,25Wh/m3
			Maximum sound from MVHR unit	30,7dB

LOW-ENERGY BUILDINGS

ESM: RECENT LEBS / SUPPLY SYSTEMS

GENERIC ESM GLOBAL DESCRIPTION

TYPOLOGY
Recent Low Energy Construction/Installation of supply systems (space heating and domestic hot water)

INITIAL ISSUE RELATED TO THE ESM
A lthough the demand for space heating in low energy buildings is very low, a supply system is needed to generate space heating and hot water. Ideally, a significant share of the energy requirement should be supplied by renewable sources.

GENERIC ESM TECHNICAL DESCRIPTION

TECHNICAL ASPECTS

Thanks to its highly insulated shell and its airthickness, needs for heating are reduced

There are different possibilities to provide space heating and hot water in residential buildings.
The systems that will be potentially observed in WP 7 are:

- **Calorific value boiler**
- **Heat pump**
- **Combined heat and power**
- **Biomass**
- **District heating**
- **Solar thermal**
- **Photovoltaic**

Furthermore, for all heating systems it is **important to avoid heat distribution and heat losses through short pipe length and well insulated pipes**.

The **main evolutions linked with the emergence of the Low Energy Buildings** are:

- the **exceptional average thermal performance for the new boilers** with savings on every kWh.
- the **link with renewable energy and a new mix between the gas and the other renewable energies**.

MAINTENANCE, OPERATION AND MANAGEMENT ASPECTS

Depending on the system, different maintenance measures are necessary (see specification of SHOs in chapter 3).
A maintenance contract agreed upon with skilled and specialized companies is recommended.

TENANTS' EMPOWERMENT ASPECTS

Comfort in respect of room temperature and availability of hot water effect the energy consumption and energy costs.
Saving potentials can be gained by individual behaviour of the inhabitants and by overall interventions affecting the room temperature and the hot water supply. In order to gain the saving potentials inhabitants have to be informed and the acceptance of the intervention needs to be reached.

TIPS AND ATTENTION POINTS

☑ USE TERMINAL REGULATION TOOLS WITH A RAPID ANSWER

Terminal regulation of the heating system is often ensured by thermostatic valves. **Thermostatic valves can be a problem due to a slow reaction time and are often close only when the temperature reach 21° or 22°.**
In a low energy building, these high temperature bring to heating losings and overconsumption.
As a consequence, **existing substitutes will have to be found to improve this terminal regulation**: for example, an thermo-electric actuator linked with a room thermostat can be implemented. A heating resistance is positionned on the sensible part of the thermostatic valve, the thermostat close when the optimal temperature is reached provocking a warming of the resistance and a dilatation of the sensible part of the thermostatic valve aiming a closing more rapidly the valve.

☑ IMPROVE THE AWARENESS OF THE TENANTS

Tenants will have a major role in the good efficiency of both the heating systems and the water consumptions.
SHOs have to be particularly focused on the **awareness** and the education of the tenants in buildings where behaviors will have a major impact on the energy efficiency.
AFTER WP3 provide a number of solutions regarding the communication with the tenants about energy stakes.

In a LEB this process will have to be enhanced due to the complexity of the systems and the high potential for causing disorders and overconsumption of the behaviors.
The awareness of the tenants regarding the windows opening is really important in low energy buildings.
cf. WP3 Factsheets.

☑ OPTIMIZE THE REGULATION OF THE HEATING CURVES

The heating curve is a regulation which fix the water temperature of the heating system in fonction of the external temperature. The heating curve is useful to make the terminal regulation working more easily an more precisely and to reduce the losings regarding the distribution thanks to a reduction of hot water temperature in the system.
If the heating water are badly regulated, the temperature level in the apartments could be too high and lead to an overconsumption.

In a low energy building the regulation of the heating curve will be really important both because too important temperature can lead to massive overconsumption (more than 10% for one supplementary degree) and also because the internal and solar gains will have a major influence on the temperature and comfort. As a consequence, the heating curves will have to be regulated and optimized during the life and the occupation of the buildings.

☑ AVOID THE OVERDIMENSIONING OF THE SYSTEMS

Overdimensioned heating systems are costly, cause short cycles and can have negative consequences regarding the average annual yield of the systems. This overdimension will have impacts on the costs for the tenants and provocke complaints. This overdimensiong will also imply supplementary dirtying of the heating system and its ageing.
Overdimensioning of the heating system is often link to a precautionary excess regarding heating capacities («if you can move mountains, you can move molehills» principle) and comfort (especially to be more efficient regarding the transition between the night and the morning).
A major attention has to be carried out regarding the dimensioning and architecture of the heating system, the **calculation only thanks to the habited volume is not sufficient**. **The power of the boiler has to be optimized thanks to a report of the average losings of the building**.

This attention has to be carroed out for all the heating system and network: tubes and pipes, selection of the circulators, etc.

☑ OPTIMIZE THE INSULATION OF THE HEATING NETWORK

The **insulation of the tubes, pipes and valves part of the heating network** have to be implemented in order to reduce the heating losings.
In order to optimize this insulation some necessary precautions have to be taken:

- insulation of DHW external pipes.
- respect of a minimum spacing between the pipes, and between the pipes and the walls and roof in order to protect them with the appropriate thickness of insulation.
- reserve space to add insulation when a pipe pass through a wall
- attention to the diameter of the insulation in order to avoid air circulation between the pipe and its insulation or add clamping rings.
- protect valves with shells.

DETAILED ASSESSMENT
Values extracted from a x sample of dwellings

SPEKTER poslovanje z nepremičninami Savinjska cesta 9b, Trbovlje, SLOVENIA	**Number of dwellings** 13 **Number of floors** 5 **Heated surface** 786 **Inhabitants** 38 **Year of construction:** 2006	<u>**Space heating & Hot water energy supply:**</u> **District heating with custom built district heating substation (supply power:76 kW).**	**Cost of the investment**	Unknown, handled by district heating provider
			Energy carrier(s)	Gas (district heating)
			Form of heat transfer	Radiators with thermostatic valves
AARHUS KOMMUNE Langballevej 9A-9H, Mårslet, DENMARK	**Number of dwellings** 8 **Number of floors** 1 **Heated surface** 623 **Inhabitants** 8 to 16 **Year of construction:** 2011	<u>**Space heating & Hot water energy supply:**</u> *** Floor heating directly connected to district heating supply** ***DANFOSS® CF2 System Wireless Floor Heating Control System, DANFOSS® TWA Actuator*** *** 6 photovoltaic panels placed on roof above individual dwell-ing units with individual converter (0.154 kW/m2 Peak power and system efficiency of 0.752)** *** Balanced mechanical ventilation with heat recovery and by-pass function.** **cf. WP7 ESM: Ventilation**	**Cost of the investment**	Photovoltaics: 63.500,00 EUR Plumbing: 23.200,00 EUR Ventilation: 28.100,00 EUR
			Energy carrier(s)	2013: Approx. 40% biomass (mainly straw and domestic waste) and 60% coal. Aconversion to 100% biomass is undergoing
			Form of heat transfer	Individual under floor heating system
bauverein AG darmstadt Elisabeth-Selbert-Straße 6-8, Darmstadt, GERMANY	**Number of dwellings** 44 **Number of floors** 4 **Heated surface** 3457 **Inhabitants** 90 **Year of construction:** 2010	<u>**Space heating & Hot water energy supply:**</u> **District heating (supply power: 60 kW)** **Heat Exchanger (cf. WP7 ESM: Ventilation)** **Outside temperature compensated control**	**Cost of the investment**	178 000 EUR
			Energy carrier(s)	Gas
			Form of heat transfer	Radiators

 **2 rue Camille Guérin, Bétheny, FRANCE**	**Number of dwellings** 13 **Number of floors** 4 **Heated surface** 1538 **Inhabitants** 30	**Double-flux ventilation with individual place heat recovery exchanger ALDES Dee-Fly 300 Micro-Watt (terminating resistors low-power UBio ALDES integrated to the ventilation system).** **+ radiant panel in the bathroom** **+ 15 solar cells on the roof (34,5 m2) completed with individual tanks.** **+ Earth cooling tubes**	**Cost of the investment**	Earth cooling tubes : 11 288, 62 EUR
			Energy carrier(s)	Electricity Ground.
			Form of heat transfer	Ventilation. Panel

INVENTORY

SUMMARY REPORT AND CONCLUSION

The AFTER project Inventory meets several requirements for the decisioners and the technical services of the European Social Housing Organizations. Beyond the collection and definition of the most representatives existing energy saving measures, AFTER has highlighted some major expectations from the participating members.
The aim of the second phase of the project is to deliver on these priorities. The testing on Pilot Sites will be an opportunity to deepen the working knowledge concerning the main topics included in the Inventory.

As a conclusion to this deliverable, AFTER partners have reached the following conclusions. The Inventory process has been important as it has allowed to orientate on two directions:

- A precision regarding the stakes of the testing and optimization phase (including the main methodological boundaries to select relevant energy saving measures for optimization).
- A thematic index of interest topics to guide the selection of the Pilot ESMs and guarantee their relevance and their representativeness.

I. METHODOLOGICAL FRAMEWORK FOR THE PILOT ESM SELECTION

The Inventory process has led to some strategic guidelines for the next steps for the project. The objective for this guidelines is to focus on a very pragmatic and professional approach for the Social Housing Organizations. The selection will have to answer to practical issues mentioned by the participating partners.
In order to harmonise the panel of the selected measures, the following points and commitments will have to be respected by the partners.

I.2. TARGETING THE GLOBAL SCALE OF THE HOUSING STOCK

Identifying energy savings in all types of frames.

Regarding the topics of the management and maintenance of the buildings, AFTER will focus on the entire social housing stock to generalize and maximize good practices regarding energy performance .
The objective aims at achieving energy savings where they are most immediately easily feasible, both in ancient buildings and in the post-delivery phase for the new low-energy buildings.

I.2. BUILDING AN INTERFACE CONCERNING COMPANIES POSITIONING

A General overview of the strategies implemented by the members DELPHIS companies in terms of energy performance.

AFTER will have to highlight the differences in positioning and stragies of the participating Social Housing Companies.
This methodological concern is important as it will provide a better ovierview to understanding a decision-taking process and the economical/organizational conditions to implement an energy saving measure.

I.3. ESTABLISHING A COMMON KNOWLEDGE BASIS

Sharing of information, feedback and best practices of the technical services between member companies

This approach involves different ambitions :

- to provide a common repertoire of practices having achieved satisfying feedbacks, but also prevent any difficulties in also putting forward practical problems encountered in practice.
- to identify relevant stakeholders have been working with some of the participating members but also offer pieces of information about the main figures related to the energy saving measures (price levels, quality of some equipment , etc.).

I.4. USING A COMMON ASSESSMENT TOOL

Providing a new definition of what is the energy performance

Through their discussions and exchanges, participating partners will lay offer a complex and plural definition of the energy performance including measurements of consumptions but trying also to highlight some social impacts (comfort, eco-empowerment, etc.).
AFTER partners will work in order to select and adpat, for every selected measure, indicators relevant to measure and assess the energy performance for the selected measures.

II. PRIORITY THEMATIC AREAS FOR THE TESTING PHASE

Project members have inventoried during the first phase of the project topics identified as priorities for the improvement the energy performance in existing buildings.
These main families of energy saving measures gather groups of ESMs listed in the Inventory. They have been used to select the 18 Pilot ESMs to implement on Pilot Sites for optimization purpose.

National Advisory Boards have created in the 6 countries represented in the project. These boards include tenants' representative organisations, project partners of the concerned country, National Housing Associations and other organizations. These National Advisory Boards have assessed the Inventories provided by their national Social Housing Organizations in order to identify the most relevant saving measures.
Participants of the National Advisory Boards have evaluated the transferability potential of the listed ESMs and suggested some optimisation possibilities that may be able to enhance the economic, energy and social performance for the energy saving measures.

Reminder: AFTER Pilot ESMs will be divided into 5 major groups of action: OPERATING MANAGEMENT/RUNNING MAINTENANCE/REPLACEMENT OF SYSTEMS/RECENTLY REFURBISHED BUILDINGS /RECENT LOW-ENERGY BUILDINGS.

For each identific the topics, this synthesis will provide: a short description of its content and some clues regarding the types of optimization that may be identified during the testing phase of the project.

TOPIC 1:
THE OPTIMIZATION OF ENERGY PERFORMANCE GUARANTEE IN HEATING CONTRACTS

(WPs: OPERATING MANAGEMENT AND RUNNING MAINTENANCE)

The guarantee for the energy performance is a major issue operating contracts for the heating providing and the maintenance of the heating systems.

This topic cover up in several sub-themes :

- the upstream identification of the consumption for a building/a group of buildings and for the housing stock of a company. This knowledge will help to identify and to optimize objectives and targeted performance that will be contracted with the energy and service provider.
- the monitoring and the measuring the actual performance of the systems during the length of the contract.
- the adjustment included in the contract to guarantee the performance and their penalty/incentive that may be implemented in order to secure the energy contract.

These main concerns can lead to some research and developments regarding the operating management of the heating contract:

- the collection of the data and figures to follow the performance of a housing stock and the information tools developed to follow the contract life-cycle (dashboards, portfolios, identification of the local problems on buildings and immediate answer of the service provider, etc.)
- the accuracy of the monitoring systems implemented to control the performance indicators for a building and to cummincate to the relevant stakeholder the information on-time.
- the recording , processing, and use of data collected (monitoring and supervising the proper execution of contracts by an external provider for example).

The energy performance in the heating contracts are linked with both the definition of the objectives between the stakeholders and the monitoring systems implemented in order to control and adjust this performance quickly and efficiently.

TOPIC 2:
TENANTS AWARENESS AND EMPOWERMENT CONCERNING THE USE OF THEIR HOUSEHOLD

(WPs: OPERATING MANAGEMENT)

Behavioral aspects are key issues in the guarantee for energy performance. Without adapted uses and some involvement of the tenants, a major part of the technical energy saving measures will be ineffectual. The scientific litterature mentions some interesting results concerning the potential concerning the eco-empowerment of the tenants in their daily routines (4,6% of reduction of energies thanks to room temperature reduction and lower temperature of the domestic hot water used for dish washing for example)[1].

This involvement of the tenants and the limits of intervention of the social housing organizations about it has to be tackle regarding several aspects:

- the level and the requirements for this support: limitation of the tenants flexibility for using their systems (preset hardware settings, ergonomy of the equipment and interfaces), direct monitoring by the SHOs staff (training
personalized energy manager) , and direct and local eco-empowerment (manuals, campaigns, etc.).
- the assessment of the efficiency for these measures (including the assessment for the economic costs, the identification of the obtained savings, the structure of the monitoring: figures, behaviorals observation) and the public targeted (focus on the most energy-consuming tenants, implementation of the campaigns after the refurbishments the delivery of the building, for the new tenants, etc.).

[1] Gardner, G.T., and Stern, P.C (2008): The short List: Most Effective Actions U.S. Households Can Take to Limit Climate Change. Environment, 2008

- the content and the type of the information providing (technical aspects, general ecological messages, etc.).
- Improvement of formats and broadcast media (ergonomics manuals, readability of display solutions, etc. .).

The general objective is to improve the efficiency of the accompanying measures and to identify more clearly what is the potential for the "soft power" awareness measures in terms of savings and social link.
These measures will be analyzed following the methodology regarding tenants elaborated by the Scientific partners of the project and included in the Scientific methodology of the project.[1]

TOPIC 3:
THE IMPORTANCE OF THE BALANCING AND CONTROL OF THE HEATING SYSTEMS

(WPs: RUNNING MAINTENANCE/REPLACEMENT OF THE SYSTEMS)

Regulation and settings are a central attention points concerning the energy savings for an heating system and equipment. The balancing of the systems is important both to guarantee a correct level of comfort for the tenants but also in order to reach the expected performance for a system. As mentioned in the technical litterature "*In a poorly balanced system, rooms near the heating plant are overheated, those further away inadequately heated. Hydraulic balancing is the only way of avoiding this problem, and in existing buildings controllable heating circuits are required in order to achieve hydraulic balancing, which requires the installation of new valves*"[2].

Several issues have been arisen during the Inventory process, in particularly regarding the identification of potential disorders:

- the implementation monitoring systems to measure the actual temperatures in the entire building and check that the system is correctly balanced in all the dwellings .
- the identification of the outdoor temperature/indoor temperature and the definition of the heating curve
- the control of the proper operational state and use of thermostats and convectors in the dwellings.

TOPIC 4
WATER-SAVING INITIATIVES

(WPS : RUNNING MAINTENANCE)

The water saving kits appear as a simple measure with a strong potential to be generalized at a large scale of the housing stock. Furthermore, the water-saving measures will be highly important in the new low-energy building where the domestic hot water is becoming one major consumption.

1 cf AFTER Scientific Methodology D2.2: Tenants awareness assessment.

2 Giebeler G., Krause H, Fisch R. (2009), Refurbishment Manual : Maintenance, Conversions, Extensions, Birkhauser Verlag AG, 2009

Equipment kits for water saving still can be improved regarding several aspects:

- Water-saving kits contents adapted to the needs of the Social Housing Companies (compatibility and power of the flow reducers , compatibility of theeconomic showers with pressure systems, alarms in showers, etc.) and t a common reference price of equipment to confirm the economic viability of the equipment (arbitration between % of flow reductions and savings/prices).
- Maintenance routines and maintenance costs (durability , resistance, etc.).
- Information of the tenants regarding the water-saving kits and the measures implemented by the technical services, awareness concerning the management and the maintenance of the equipment.

Water saving kits also raise a question concerning the relevant scale to implement such types of measures (all the housing stock, new buildings, etc.) and the correlated issue of the metering for the water consumptions.

TOPIC 5
THE MAINTENANCE AND REPLACEMENT OF VENTILATION SYSTEMS

(WPs: OPERATING MANAGEMENT/RUNNING MAINTENANCE/REPLACEMENT OF SYSTEMS/RECENTLY REFURBISHED BUILDINGS)

The question of ventilation systems is directly connected with both technical and healthcare topics. This topic is very particular as it will both include issues regarding to the thermal loses due to the ventilation and Indoor Air Quality expectations.
The ventilation topic is becoming a major interest in highly insulated new and refurbished buildings. This focus on ventilation has been validated by the recent document "*Possible Ecodesign and Energy Labelling Measures for Ventilation Units*" of the Enterprise and Industry Directorate-General of the European Commission. This document insists on the major potentials regarding ventilation in the dwellings in terms of energy savings. It also highlights some of the main barriers regarding strongest investment concerning the ventilation[3]. The proposal brings some concrete measures to be applied in order to develop a labellisation of the ventilation product until 2017.

3 European Commission, Enterprise and industry directorate general. Possible Ecodesign and Energy Labelling Measures for Ventilation Units, Brussels, 2012

"Ventilation is one of the last items on the building-budget and the tendency to save some money by choosing the cheapest solution instead of the best solution is strong."

RVU/ NRVU*		2015	2017	Benchmark
both	Heat recovery for balanced systems	mandatory (with bypass)		
	Drive	3-speed or variable speed		
	Internal and external leakage (and mixing rate for local balanced units with fixed in- and outlets)	-	<10% (or similar, depending on test method)	
	Visual filter change warning	-	mandatory	
RVU	Control	-	at least clock control (CTRL factor 0,9)	
	Heat recovery thermal efficiency	75%	80% local 85% central	90%
	SPI (el. power) in W/m³/h	0.23 unidirectional 0.35 balanced	0.18 0.28	0.08
	Noise dB	45	40	

Figure 5. Summary Table Ecodesign requirements for residential ventilation units.

Part of the exploitation for the Inventory in the testing phase of the project will highlight the attention points concerning the ventilation systems that have to be respected in order to follow this direction. This attention points may include;

- the qualitative integration at the moment of the design phase (books of specifications, access to the ventilation units for maintenance, ergonomic instructions for technicians, dimensioning of the systems to guarantee the good air flow, prevention of noise disturbances)
- the improvement and preparation of the maintenance contracts and the qualitative follow-up for their interventions.
- the monitoring of the proper functioning and performance of the installations (monitoring solutions, remote energy meters , frequency of the measurements, warnings, etc.)
- information and assistance for the tenants regarding the good behavior (personal communication systems , diffusion of pollutants in the housing).

TOPIC 6
THE CHOICE OF BOILER REPLACEMENT
(WPs : REPLACEMENT OF THE SYSTEMS)

Regarding the technical performance of the boiler, the question of maintenance and management of the heating systems is a major attention point to integrate in an optimization process.

Several sub-themes have merged during the Inventory process and thanks to the National Advisory Boards organized during the first phase of the AFTER project:

- the importance of the dimensioning for the boiler and the link power/efficiency during the decision-taking process (adaptation of the boiler dimensions to the heated volume and the existing radiators, model of boiler)
- the fragility of equipment and the corresponding preventive actions (eg:. Implementation of a monitoring system to test the water quality and to avoid slush in the systems, insulation of additional parts of the heating system)
- the implementation of procedures and control routines (settings to control, intervention of an external provider, follow-up of the information, etc).
- boiler using wood renewable resource and assessment of economic efficiency of such systems based on territorial contexts (local availability and price for wood resources , storage combustion equipment , maintenance of the boilers).

TOPIC 7
THE PROCESSING AND OPTIMIZATION OF THE BUILDING ENVELOPE
(WPs: RECENTLY REFURBISHED BUILDINGS)

The economical context and the costs for new highly-performant systems encourage to focus on the energy refurbishment as a strong lever to improve the general efficiency of the housing stock[1]. Major progress has been done regarding the performance of the insulation materials and processes. Nevertheless, a more general approach of the refurbishment processes has still to be implemented in order to improve the efficiency for these investments[2].

A more detailed analysis of the issues concerning the insulation for buildings will observe the following items:

- arbitrage and choices concerning External Thermal Insulations (choice in materials depending on the price levels and efficiencies, preservation of materials, complexity of implementation, maintenance of the insulation material).
- reduction of the thermal bridges and particular points of insulation for the shell.
- coupling of the thermal insulation and the ventilation systems of the buildings put in order to prevent humidity, condensation and to ensure quality indoor air.
- implementation of the insulation in of common areas (parking, garages, etc.).
- green roofs: costs and constraints associated with their maintenance.
- interim solutions to External Thermal Insulations (punctual interventions on the heating shell, insulation of the gables) .

The general issues related to the insulation concern balancing between innovative materials, induced costs and technical

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2 Low Carbon Domestic Retrofit. Retrofit insights: perspectives for an emerging industry. Key findings: analysis of a selection of Retrofit for Future projects. Institute for Sustainability, London, 2012.

"Low carbon retrofit is characterised by high costs for key sub-systems, for example external solid wall insulation. The marginal payback time of the last millimetre of insulation rises as the square of the total thickness – increasing the thickness of insulation in a wall from 50 mm to 250 mm means, crudely, that the last millimetre takes around 25 times as long to pay back. Nevertheless, the high fixed costs associated with measures such as external solid wall insulation mean that the payback time for the whole insulation package is flat over a wide range of insulation, with steeply rising costs as carbon reduction targets increase."

implementation. The refurbishment and the new air thickness of the building will have to impact the global reflexion on the ventilation system, the adjusted temperature setpoints.

TOPIC 8
THE BBC AND INTEGRATION OF THE MANAGAMENT AND MAINTENANCE ISSUES AT THE PREPARATORY STAGE
(WPs: RECENT LOW-ENERGY BUILDINGS)

Social Housing Organizations begin to collect some interesting feedbacks regarding Low-Energy buildings. This feedback and the corresponding figures help to better understand what is the actual performance and the real functional qualities for such type of buildings.

Significant investments have been implemented to obtain highly insulated buildings. This performance of the insulation impacts the other systems and the global understanding of the flows in the building (efficiency of the ventilation and thermal loses due to the extracted air, part of the consumptions for the domestic hot water, etc.).

The low-energy buildings are also characterized by two points:

- the multiplication of the supply systems implemented as back-up power sources (photovoltaïc panels, heat pumps, etc.).
- the complexity of the new systems (settings, use, implementation, etc.).

The integration for the "management and maintenance" is an important challenge[1]. The objective is to guarantee a good performance for these new buildings preventing the disorders of the equipment while controlling as possible additional costs. The aim is also to improve the comfort for these buildings and to be sure that the tenants behaviors will not degrade the expected energy performance.

These aspects have to be integrated both during the phase of design and conception, and during the phase of delivering of the dwellings to the tenants. The AFTER project targets concerning these points both concern the technicians of the SHOs staffs and their tenants.

Among the potential optimization opportunities concerning the new low-energy buildings, some research and development options are interesting to follow:

- the choice of ventilation and the debates about the long-term efficiency for the double-flux ventilation systems (control of the use and potential difficulties for the tenants and the Social Housing Organizations' staff, failures and maintenance issues, Indoor Air Quality performance in highly insulated buildings, comparative performance with other ventilation systems).
- quality and performance of the solar heat systems (avoiding the residual heating during the summer and the losings during the winter time).
- the energy consumptions for domestic hot water regarding very low-consumptions for the heating in efficient dwelling in order to find further improvements.
- the thermal comfort and the optimization of the solar gains in buildings equiped with high performance windows and frames.
- the advanced assessment of the tenants behaviors' in buildings were their behaviors will have a stronger impact.

This topic is quite innovative as the practical experience regarding these buildings is still limited by the lack of feedbacks. AFTER partners have some interesting buildings to analyze. The optimizations proposed for this building will open new possibilities to obtain energy savings in already performant buildings.

III. SELECTION OF THE 18 PILOT ESMs

The selection of the 19 Pilot ESMs has been prepared by the participating Social Housing Organizations and the Scientific partners. Their final proposals have been discussed and validated by the National Advisory Boards.

The Social Housing Organizations have proposed Energy Saving Measures regarding the selection criterias including:

- the optimization potential of the Pilot building and the implemented ESM regarding economic, energy and social savings. This potential was directly depending on the professional knowledge of the Social Housing Organization. This means that we focus on efficient measures that still carry some identified opportunities to be improved thanks to small adjustments in order to enhance their general performance.
- The representativeness of the ESM in the social housing stock of the participating Social Housing Organization and its potential to be reproduced and planned on more buildings until 2020.
  - The potential of the optimized measure at a national scale. Measures concerning a large part of the national housing stock have been selected in order to identify potential lessons for the future. The objective is to enlarge the scope of application for the project and to include the main national concerns and contexts about the implemented measures.
  - The potential to involve the tenants and to improve their comfort and eco-empowerment concerning savings in their own household. This criterion is directly out of the importance for the behavioral impacts as detailed in the project Scientific methodology and in this deliverable.
  - the communication of the best practices across Europe.

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1 CASH (Cities Actions for Sustainable Housing), Energy efficiency for social housing, Baseline Study, URBAN Act II, 2010

« Although new houses are only 1 to 3 per cent of the housing stock, it is important to develop and introduce energy-effi cient technologies for new housing construction. Eventually it is new housing that will determine the status of energy-efficient housing in the future. (...) New buildings are rarely improved or renovated in the first years. The efficiency of new buildings will therefore directly influence the consumption for many years and they will be the standard for improvement of existing buildings, since renovation projects often aim to bring buildings up to the present standard. Efficiency demands for new buildings then becomes the driver also for existing buildings.
(...) Requirements for highly-effi cient new constructions also influence the market for products typically installed
in buildings, promoting energy efficient models of windows, boilers, pumps and air-conditioners. Once on the market, these products may become standard in both new and renovated buildings. This can be observed
in the disappearance of single-glazed windows and non-condensing gas boilers from German, Dutch and Danish markets."

The project is gathering countries with various existing housing stocks and climatic contexts. The objective of the selection is to consider at the same time the necissity to integrate these national contexts and the need to promote transnational knowledge.

The following table presents all the Pilot buildings and Pilot Energy Saving Measures selected for the second phase of the project. All the proposed optimizations and the purposes for choosing these Pilot ESMs are detailed and analyzed in the deliverables for the testing phase.

The enclosed table presents, as a conclusion, the main aspects of this selection detailing:

- the name of the Pilot Site, its adress and a photo.
- the number of dwellings concerned.
- the description of the Pilot Energy Saving Measure to be optimized.
- The potential regarding economic, energy and for the ESM
- the identified objective for the optimization process.

OPERATING MANAGEMENT

	**RAMEAUX** FRANCE Allée des Monts Dorés 63370 LEMPDES	Auvergne Habitat	Construction	1970
			Dwellings	70
			Energy Saving Measure	Renewal of an energy contract contracted with an energy provider including performance objectives regarding energy consumptions, this performance is supported a profit-sharing system with the provider.
			Identified stake	Controlling the efficiency of the maintenance interventions in an profit-sharing heating contract.
	**JABURKOVE** CZ. REPUBLIC J.Jaburkové 1,3,5, 736 01 HAVIROV.	MRA	Construction	1962
			Dwellings	36
			Energy Saving Measure	Web portal created to increase the awareness and the involvement of the tenants regarding the management and the visualisation of their water and heating energy consumptions. Consumption are visualised on the web portal
			Identified stake	Improving ergonomics and awareness for a web portal about energy savings.
	**H2 COLLEGE** DENMARK Birk Centerpark 77, 79, 81, 83 + 93, 7400 Herning.		Construction	2009
			Dwellings	66
			Energy Saving Measure	First Social Passive Housing building in Denmark (university residence) : tenant information about heating system and tips/motivation in written form are delivered. This awareness process is supplied by direct information from local staff.
			Identified issues	Correcting unexpected high energy consumptions thanks to personal follow-up and training of the tenants with incentives.

RUNNING MAINTENANCE

UZAVRENA
CZ. REPUBLIC
Uzavrená 2,4,6, 736 01 Havirov.

Construction	1962
Dwellings	36
Energy Saving Measure	Regulation of flow and pressure of the heating system (installation of valves on the radiators, manual regulation valve in the basement, implementation of differential pressure regulator, setting of valves to control the flow rate in the supply network, delimitation of the circulated water quantity in the network, low return temperature in the network).
Identified issues	Improving the balancing of a heating system correcting deficiencies in its scheme.

RIESI
ITALY
VIa Riesi 5,
10043 Orbassano,

Construction	1985
Dwellings	51
Energy Saving Measure	Smart metering system based on individual heat cost allocators to improve the balancing of the new heating system.
Identified issues	Correcting the efficiency of a smart metering balancing system after unexpected results.

TR16
SLOVENIA
Trg Revolucije 16,
1420 Trbovlje

Construction	1970
Dwellings	52
Energy Saving Measure	Hydraulic balancing of the heating system: connecting valves on return flow line, balancing valves, thermostatic valves with additional fine regulation, complete system was balanced and regulated with newly installed valves.
Identified issues	Readjusting a overdimensioned system thanks to an adjustment of the heating curve.

REPLACEMENT OF SYSTEMS

BERGSON
FRANCE
Place Bergson .
63000 CLERMONT-FERRAND

Construction	1967
Dwellings	162
Energy Saving Measure	In the framework of a refurbishment, implementation a natural hybrid ventilation system combining natural ventilation and punctual mechanical help.
Identified stake	Identifying the opportunity for a natural hybrid ventilation (comparing to a permanent mechanically controlled ventilation system) system and adapting its regulation.

PASSONI
ITALY
Via Passoni 14.
10146 Torino,

Construction	1978
Dwellings	12
Energy Saving Measure	Substitution of the two old twin boilers (power: 98 kW each) with one new Condensing boiler (power: 92 kW) using natural gas. This boiler serves only the heating system; tenants have single boiler (electrical most of the time) to produce DHW in their apartments.
Identified stake	Improving a new heating system (condensing boiler) with specific low-cost interventions on missing insulation

HEINHEMER
GERMANY
Heinheimer Straße 57-61.
D-64289, Darmstadt.

Construction	1957
Dwellings	30
Energy Saving Measure	Replacement of a central standard boiler from 1982 with a new natural gas central heating system with 3 gas calorific boiler (lower flow temperature).
Identified stake	Adjusting a heating system after the implementation of a new gas calorific boiler but with old radiators.

RECENTLY REFURBISHED BUILDINGS

	**AIGUILLADE** FRANCE Rue de l'Aiguillade, Entrée 2 à 17, 63000 Clermont-Ferrand,		**Construction**	1965
			Dwellings	156
			Energy Saving Measure	Refurbishment of the roof insulation (Thermic insulation with foamglass / R=3,33 m2.kw), improvement of the ventilation system (hybrid ventilation), external thermic insulation from no insulation to a façade with external thermic insulation of polystyrene expanse (120 mm / R = 2,43 m2.kW) ; windows replacement from wood simple-glazing to PVC carpentries with double-glazing.
			Identified stake	Updating contract after refurbishment in a renewable energy-based district heating system
	**TOLSTEHO** CZ. REPUBLIC Tolsteho 1, 3, 5, 3 6 01 Havirov.		**Construction**	1960
			Dwellings	34
			Energy Saving Measure	Insulation of the facade: External Thermal Insulation Composite System (ETICS) with polystyrene EPS 70 F ; thickness 140 mm. Roof insulation Insulation of the ceiling above basement. New windows with PVC carpentries (U-value = 1,42 m.K/W (also implemented in the hallway)
			Identified stake	implementing small complementary interventions on a refurbished building without having to operate within the appartments
	**MATHILDE** GERMANY Mathildenstraße 36-40. D-64285 , Darmstadt.		**Construction**	1955
			Dwellings	19
			Energy Saving Measure	
			Identified stake	
	**PICCO** ITALY Via Picco 53-55-62-64, 10078 Venaria Reale,		**Construction**	1966
			Dwellings	28
			Energy Saving Measure	In the framework of retrofitting actions, an insulated coat of 80mm was implemented. Existing single glazing were substituted with high performance double-glazing (aluminum windows with double glazing and shutters in PVC + cellars windows on the ground floor made of iron with single glass). At the same time, the heating system was improved by the installation of new condensing boilers and solar panels (for Domestic Hot Water).
			Identified stake	Raising tenants attention in a post-refurbished building about the impact of ventilation.
	**LYSTRUP** DENMARK Centervej 30-56, 8520 Lystrup		**Construction**	1984
			Dwellings	14
			Energy Saving Measure	Sloping roof insulation. Thermal insulation of roof. External carpentries replacement. Facades internal insulation. Solar panels mounted on the roof. New windows with Double Heat protection Glass. New heating system: underfloor heating + balanced mechanical ventilation with heating coil supplied by district heating and heat recovery.
			Identified stake	Adjusting the combination of heating systems in order to enhance the efficiency for heat recovery ventilation system during the intermediary season (target: seniors)
	**TFF2A** SLOVENIA Trg Franca Fakina 2a, Trbovlje		**Construction**	1990
			Dwellings	31
			Energy Saving Measure	Reinforced concrete building with 6cm insulation additionally insulated with 7cm insulation. . U = 0,27 W/m2K(before: 60 W/m2K)
			Identified stake	Raising tenants attention in a post-refurbished building with group training

RECENT LOW-ENERGY BUILDINGS

	**MAARSLET**	AARHUS KOMMUNE	**Construction**	2011
	DENMARK		**Dwellings**	8
	Kildevang, Langballevej 9A-9H, 8320 Mårslet.		**Energy Saving Measure**	Roof insulation 445mm, Walls Insulation 200mm , Windows & Frames Insulation 300mm / Sun Protection (U=1,20 w/ m2*k incl. frame and sash), Photovoltaics: solar panels on the roof 7.66 per m2. house (0.154 kW/m2 Peak power and system efficiency of 0.752).). Balanced mechanical ventilation with heat recovery and by-pass function. Floor heating directly connected to district heating supply. Decentralized heat-exchanger for Domestic Hot Water supplied by district heating.
			Identified stake	Optimizing the energy consumption requested by dhw production in a low-energy building
	**WOHNART3**	bauverein AG darmstadt	**Construction**	2010
	GERMANY		**Dwellings**	44
	Elisabeth-Selbert-Straße 6-8, 64289 Darmstadt,		**Energy Saving Measure**	Passive house standard planned in PHPP (Passive House Planning Package - «The modelling software for Passivhaus buildings») including an nnsulation of the facade with 30 cm Expanded Polysterene, a double-flow ventilation system and triple Heat protection Glass. Electric warm water tank.
			Identified stake	Adjusting the running time of the systems for domestic hot water in a passive house
	**SC9B**	SPEKTER	**Construction**	2006
	SLOVENIA		**Dwellings**	13
	Savinjska cesta 9b, Trbovlje,		**Energy Saving Measure**	New building with 10cm Expanded PolyStyrene (EPS) shell insulation, min. 10cm EPS roof/ceiling insulation and 8cm EPS for the basement floor insulation. Double glazed windows. No heat recovery or ventilation systems. Temperature is regulated with a night reduction clock, external sensor and immersion sensor. On each floor there is a manifold with apartment connections, each connection has a shut-off valve. Inside the apartments, temperature is regulated with thermostatic radiator valves.
			Identified stake	Upgrade an existing low-energy building to a new level of performance thanks to a better balancing of the heating system

DARMSTADT
HAVIROV
TRBOVLJE
CLERMONT-FERRAND
TORINO

INVENTORY

EXPECTED OUTPUTS FOR THE SCIENTIFIC METHODOLOGY ARE:

O 1. An European methodology to assess the impact of energy savings measures
O 2. Retro-commissioning of residential buildings methodologies are adapted to SHO needs and disseminated in European SHO.

The content include in this document is corresponding to the following deliverables as mentioned in the Annex I of the AFTER project IEE 10/344.

aFTeR
COST OPTIMUM AND STANDARD SOLUTIONS FOR MAINTENANCE AND MANAGEMENT OF THE SOCIAL HOUSING STOCK

D2.1	***Energy Savings Measures impact assessment conceptual framework***
D2.2	***5 adapted versions of the global methodology for the 5 types of ESM***
D2.3	***Context-adapted versions of the 5 specific ESM assessment methodologies and data collection templates***
D2.4	***Common evaluation protocol for the testing "live" on sites of the pilot ESM***
D2.5	***State of the art of the retro-commissioning methods and tools adapted to residential buildings***
D2.6	***Common methodology of pilot sites retro-commissioning***