# AFTER

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


# AFTER SCIENTIFIC METHODOLOGY

With the support of

INTELLIGENT ENERGY EUROPE
FOR A SUSTAINABLE FUTURE

# SUMMARY

# MAPPING
## AFTER DEFINITIONS




**ESM** **Energy Saving Measure**

- is implemented in order to improve the energy consumption of a building and related to heating aspects, warm water or electric poering for heating equipments.
- its impacts can eventually be monitored and evaluated regarding kWh and heating energy costs.
- can be optimized/influenced/present a potential to be improved.
- respect the time line presented below.

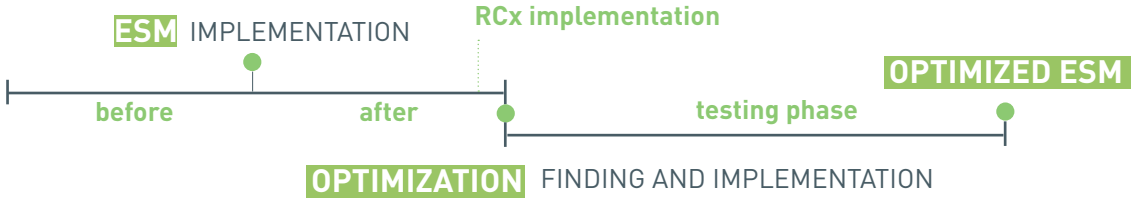
**OPTIMIZATION** **Optimization**

- is related to an ESM which show potential of improvement
- this potential can concern the 3 following objectives:
  - improve the economic model of the ESM.
  - enhance the energy efficiency.
  - increase the social performance and the reception of the ESM by tenants.)
- can lead to several types of actions:
  - management & strategic decision
  - technical intervention (control, maintenance, replacement)
  - increase the social performance and the reception of the ESM by tenants.

**OPTIMIZED ESM** **Optimized ESM**

- is the definitive version of the original ESM corrected with the optimization leads and tested during the implementation phase

**TIME LINE** **Time line**



# MAPPING
## AFTER SCIENTIFIC METHODOLOGY

**The AFTER project develops a complete scientific methodology in order to optimize Energy Saving Measures implemented within the Social Housing Stock.**
**This Scientific methodology articulates conceptual tools and reporting formats.**

**The conceptual tools will define a common framework for analyzing and identifying the ESMs related to management and maintenance in the housing stock. These tools will lead the SHOs in the selection process of the most relevant ESMs and their optimization suggestions.**
**The reporting formats will present the results highlighted thanks to the methodological tools of the project.**
**This document present a cartography showing the process and the links between the different methodological documents of the AFTER project.**

AFTER methodological process is built on several complementary documents that design a global assessment framework.

The main objective is to obtain several filters aiming at selecting 18 Pilot ESMs (with optimization suggestions) on 18 Pilot Sites. AFTER's final ambition is to test some optimization solutions that can be applied on Pilot buildings having received some energy saving efforts during the last 5 years.
In order to accomplish this aim, AFTER settles an iterative process. This process consists in looking back at a building in order to see what can be improved after an existing improvement. Thereof, AFTER methodology is organized step-by-step on different scientific tools.

### OVERVIEW OF THE METHODOLOGICAL DOCUMENTS AND REPORTING FORMATS - PHASE 1: INVENTORY AND PILOT ESMs IDENTIFICATION

The **Questionnaire** aims at soliciting the SHOs in order to identify what ESMs have been implemented on their housing stock during the last 5 years.
The Questionnaire is a first approach for the SHOs, a first search in the past histoy of the energy efficiency efforts implemented within their housing stock.

In order to structure this identification, Scientific partners develop a typology list for every Work Package. This **Typology list** will be used as a dictionnary of what can be defined as a potential Energy Saving Measure related to the management and maintenance of buildings.
The typology list offers a complete overview of the types of ESMs linked with the operating management (WP3), the running maintenance (WP4) and the replacement of the systems (WP5). This overview is precised regarding the specific cases of the recently refurbished buildings (WP6) and the recent low-energy buildings (WP7).

The ESMs collected by the SHOs are reported with

# MAPPING
## AFTER SCIENTIFIC METHODOLOGY

corresponding data in the **Inventory**, which is the first data basis of the AFTER Project.This Inventory is structured thanks to a framework developed and precised in the **Handbook** of the project.
The Handbook will be used during the whole project. It proposes common definitions regarding the indicators used in the project. The ESMs description in the Inventory follows the structure of the Handbook.
A «Frequently Asked Questions» (**FAQ**) file has been created in order to collect the different questions of the partners and to insert a common answer in the Handbook.

The most relevant ESMs tested are reported in a synthesis: **the report on the most innovative measures**.
This report highlights relevant ESMs to improve regarding the management and the maintenance of the social housing stock. The report is completed with the Factsheets, presenting a simple description of the several ESMs collected during the Inventory process. These ESMs are completed with data and can be used as a catalogue of existing experiences for the partners and the dissemination of the project toward other Social Housing Organizations.
**Top-ten lists** have been created by the partners in order to identify priorities and to optimize priority topics. Knowledge and experience of the partners have been useful to provide these lists.
Thanks to the identification of these priorities, Social Housing Organizations select 18 Pilot ESMs on 18 Pilot Sites that will have to be optimized during the second phase of the project.

These couples of Pilot ESMs and Pilot Sites will be the core of the AFTER Project: they are the laboratory for the second phase of the project.

### OVERVIEW OF THE METHODOLOGICAL DOCUMENTS AND REPORTING FORMATS - PHASE 2: OPTIMIZATION OF THE PILOT ESMs.

Pilot ESMs and Pilot Sites will be then analyzed in order to identify possible optimization solutions in order to improve their energy efficiency.

A **Retro-commissioning (RCx) Investigation Plan** is implemented on every Pilot Site in order to identify potential deficiencies of the building.
The RCx process is defined as the «systematic, documented process that identifies low-cost operational and maintenance improvements in existing buildings and brings the buildings up to the design intentions of its current usage.".

In the AFTER Project the RCx IP implementation will mainly consist in a crossed analysis of the buildings shared by the scientific partners and the Social Housing Organizations. This RCx IP is based both on the data analysis of the building and on one on-field observation. The RCx IP offers a process to identify the different signals that a building can send to an observer about its energy efficiency.
RCx IP is a voluntary process that implies a knowledge of the building, its documentation and the
a special attention to its main actors (tenants, caretakers, service providers, maintenance staff of the SHO, etc...).

The RCx and the involvement of the different partners will allow to identify the optimization solutions and adjustments that will be assessed during the second phase (the implementation and testing phase) of the AFTER Project.

Once these optimization solutions have been identified they will be tested on Pilot Sites.
The **Common Evaluation Protocol for testing live on Pilot Sites** will lead the implementation process and describe the methodology adapted to settle and test optimization suggestions on Pilot sites.
The Common Evaluation Protocol is divided into two complementary formats: a guideline that will propose a general framework and process for all the participating SHOs and an Excel Matrix that will adapt this protocol to the characteristics of every optimization solution tested.

# MAPPING
## AFTER SCIENTIFIC METHODOLOGY

The Common Evaluation Protocol presents a general process adapted to every Energy Saving Measures: the framework adapts the general lines of the IPMVP protocol to the AFTER project. This Common Evaluation Protocol will be then completed regarding the characteristics of every tested ESM.

The **Excel Matrix** will allow the scientific and the partners to signal the suggested optimization solution and to specify the testing protocol that will help to follow its implementation and to prepare its reporting for the last phase of the project.

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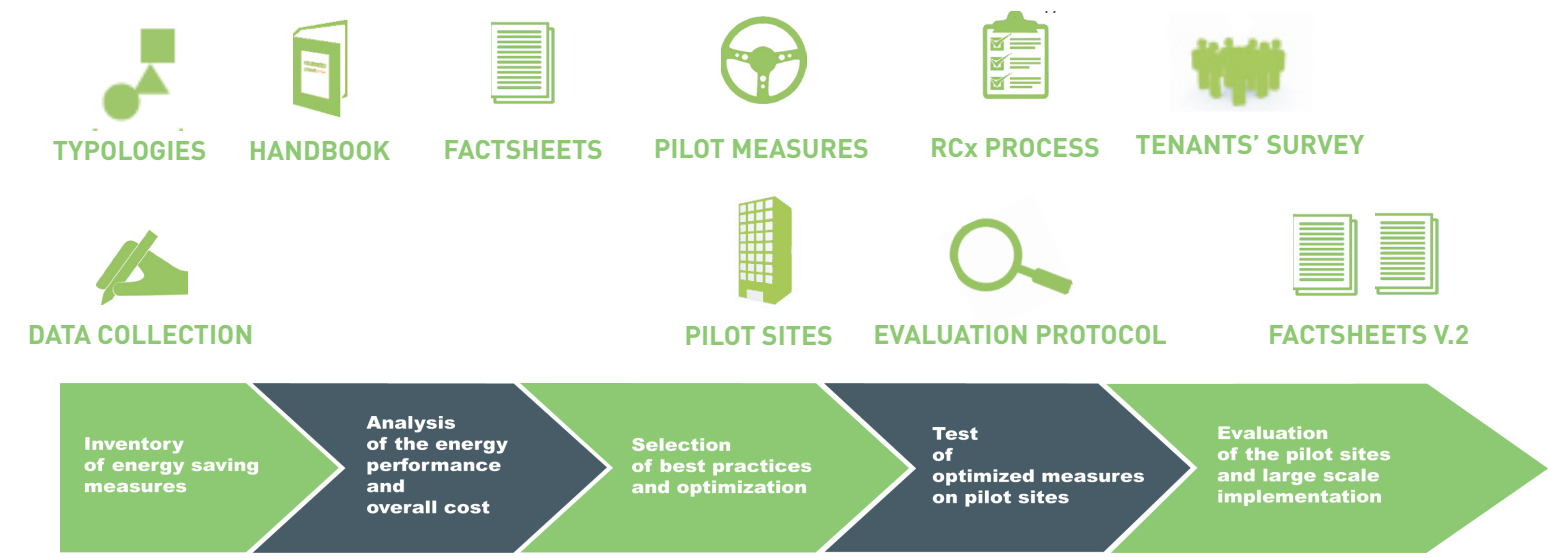
*The attached SCHEME presents the links between the different steps and methodological documents produced within the frame of the AFTER project.*



# MAPPING
## AFTER SCIENTIFIC METHODOLOGY

INVENTORY

QUESTIONNAIRE

TYPOLOGY LIST

offers a framework defining the type of ESMs included in every WP.

INVENTORY

FAQ

HANDBOOK

offers a common framework to define data and to report ESMs.

TESTING

ESM MATRIX

specify the tool regarding characteristics of the ESMs.

COMMON EVALUATION PROTOCOL

presents a common process to assess the optimization of the ESMs.

REPORT ON THE MOST INNOVATIVE MEASURES

TOP-10 LISTS

report the most relevant measures for the project.

SELECTION

FACTSHEETS

PILOT SITES

PILOT MEASURES

OPTIMIZATION SOLUTION

OPTIMIZATION

RETRO COMMISSIONING INVESTIGATION PLAN

presents a process to highlight deficiencies in one building and to suggest optimizations.

# TYPO LO GIES

# TYPOLOGIES

# TYPOLOGY
## INTRODUCTION


**The AFTER Typology list provides a framework to identify and assess Energy Saving Measures related to the management and maintenance of the housing stock.**
**The Typology list gives an overview of the potential investment to improve the energy efficiency in the buildings. ESMs and related indicators are provided for every Work package.**

The typology list presents potential ESMs to include within the AFTER project.
For every Work Package, scientific leaders present both:

- a general overview of the WP and its content identifying the systems and equipment impacted by a measure.
- proposals for Energy Saving Measures related to the systems

The typology list presents a diversity of energy saving measures included in AFTER. Its objective is to help participants to identify what are their experiences, with a common framework and vocabulary.

The typology list provides an adapted and contextual translation of the global methodology for the 5 types of ESMs connecting them with the impact assessment framework presented in the AFTER Handbook.

# TYPOLOGY
## WP3 OPERATING MANAGEMENT

**WP3 Operating Management 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.**

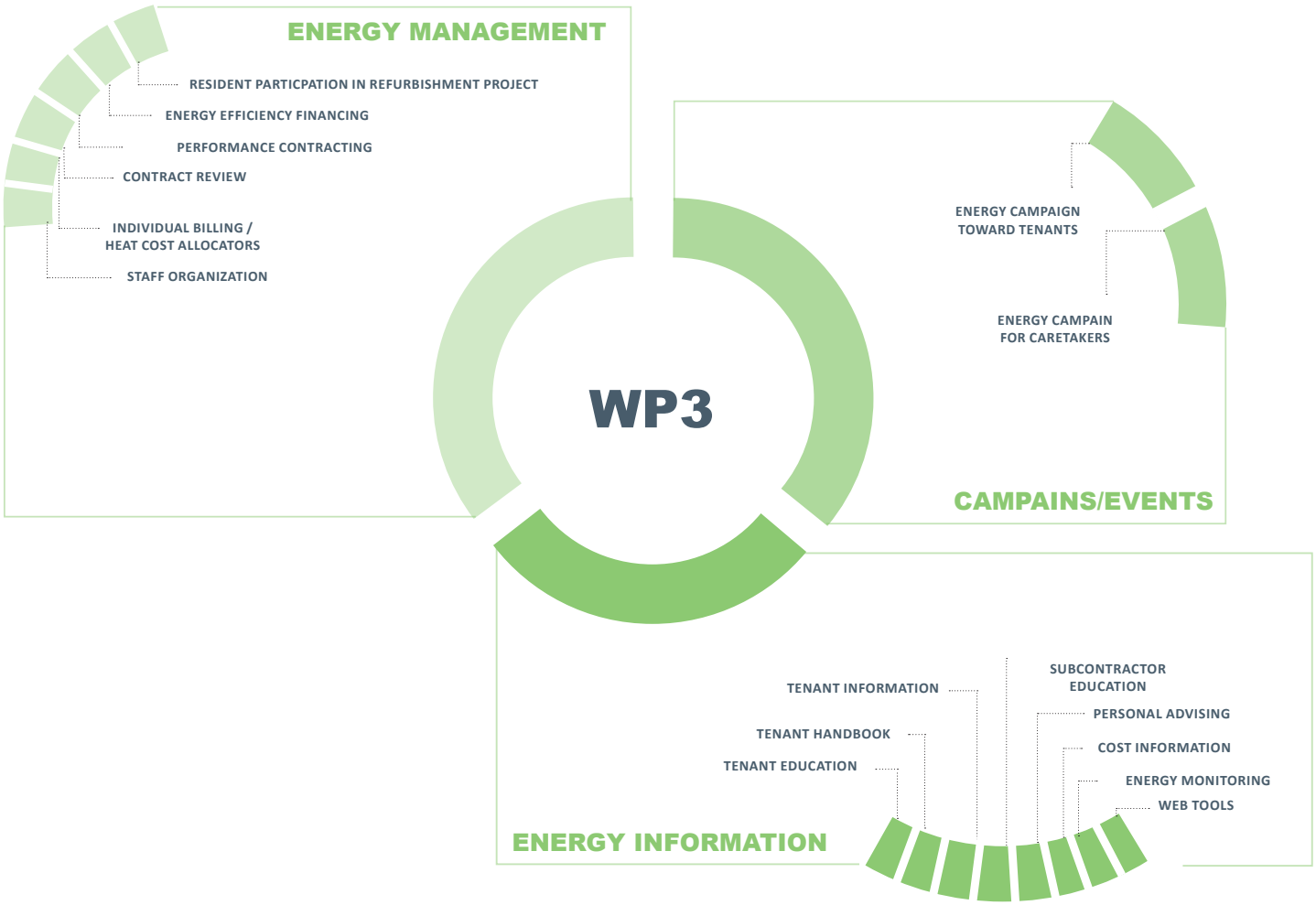
The scope of the WP 3 investigates two dimensions with two different kinds of stakeholders:

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).

# TYPOLOGY
## WP3 OPERATING MANAGEMENT



# TYPOLOGY
## WP3 OPERATING MANAGEMENT

### WHAT DO WE MEAN BY «ENERGY INFORMATION» ?

| | |
|---|---|
| TENANT EDUCATION | Training provided to residents' advisory committee to tenants through climate ambassador, to a local energy network. |
| TENANT HANDBOOK | Ventilation maintenance manual for tenants, manual for new tenants, manual for high efficiency dwelling, |
| TENANT INFORMATION | Energy personal letter, best practice display in lobby, energy certificate. |
| SUBCONTRACTOR EDUCATION | Ventilation manual for caretakers, training for subcontractors. |
| PERSONAL ADVISING | Personal visit, low energy advisor, advice on efficient light bulbs, advice on domestic appliances. |
| COST INFORMATION | Information on energy bill, comparative energy bills. |
| ENERGY MONITORING | Individual metering, individual monitoring with thermostatic valves, smart metering, interactive energy box, electric load shedding box, energy consumption display, top ten consumption domestic appliances list. |
| WEB TOOLS | Online energy consumption check, energy saving measure web portal, energy efficiency calculator. |

### WHAT DO WE MEAN BY «CAMPAINS & EVENTS» ?

| | |
|---|---|
| ENERGY CAMPAIGN TOWARD TENANTS | Climate campaign, community events on energy savings, energy efficiency week, climate competition, demonstrations |
| ENERGY CAMPAIGN FOR CARETAKERS | Any event to involve caretakers in energy efficiency : seminar, competition, ... |

### WHAT DO WE MEAN BY «ENERGY MANAGEMENT» ?

| | |
|---|---|
| STAFF ORGANIZATION | Energy manager |
| INDIVIDUAL BILLING | Heat cost allocators, individual bill |
| CONTRACT REVIEW | Maintenance contract review, energy supply contract review |
| PERFORMANCE CONTRACTING | Energy saving sharing contract, energy supply contract review. |
| ENERGY EFFICIENCY FINANCING | Energy efficiency third party finance, energy efficiency tenant contribution. |
| REFURBISHMENT PROJECT | Interviews, meetings. |

# TYPOLOGY
## WP3 OPERATING MANAGEMENT

## CHECKLIST
### EXAMPLE OF ASSESSMENT INDICATORS

**«ENERGY INFORMATION» / «CAMPAINS & EVENTS»**

- ☐ cost of investment
- ☐ staff costs involved
- ☐ service provider costs
- ☐ diffusion (scale, time range)
- ☐ design (readibility, format, support)
- ☐ description of the content (complexity of the information delivered, directivity of the intervention recommanded, orientated toward the characteristics of the individual dwelling) public targeted
- ☐ tenants satisfaction
- ☐ evolution of the tenants rent + bill

**«ENERGY MANAGEMENT»**

- ☐ Δ energy supply prices
- ☐ Δ maintenance costs
- ☐ contractual clauses analysis
- ☐ staff costs involved
- ☐ service provider costs
- ☐ evolution of the tenants rent + bill

# TYPOLOGY
## WP4 RUNNING MAINTENANCE

**WP4 Running Maintenance is specifically dedicated to ESM related to the running maintenance of the central heating and ventilation systems managed by the SHO.**

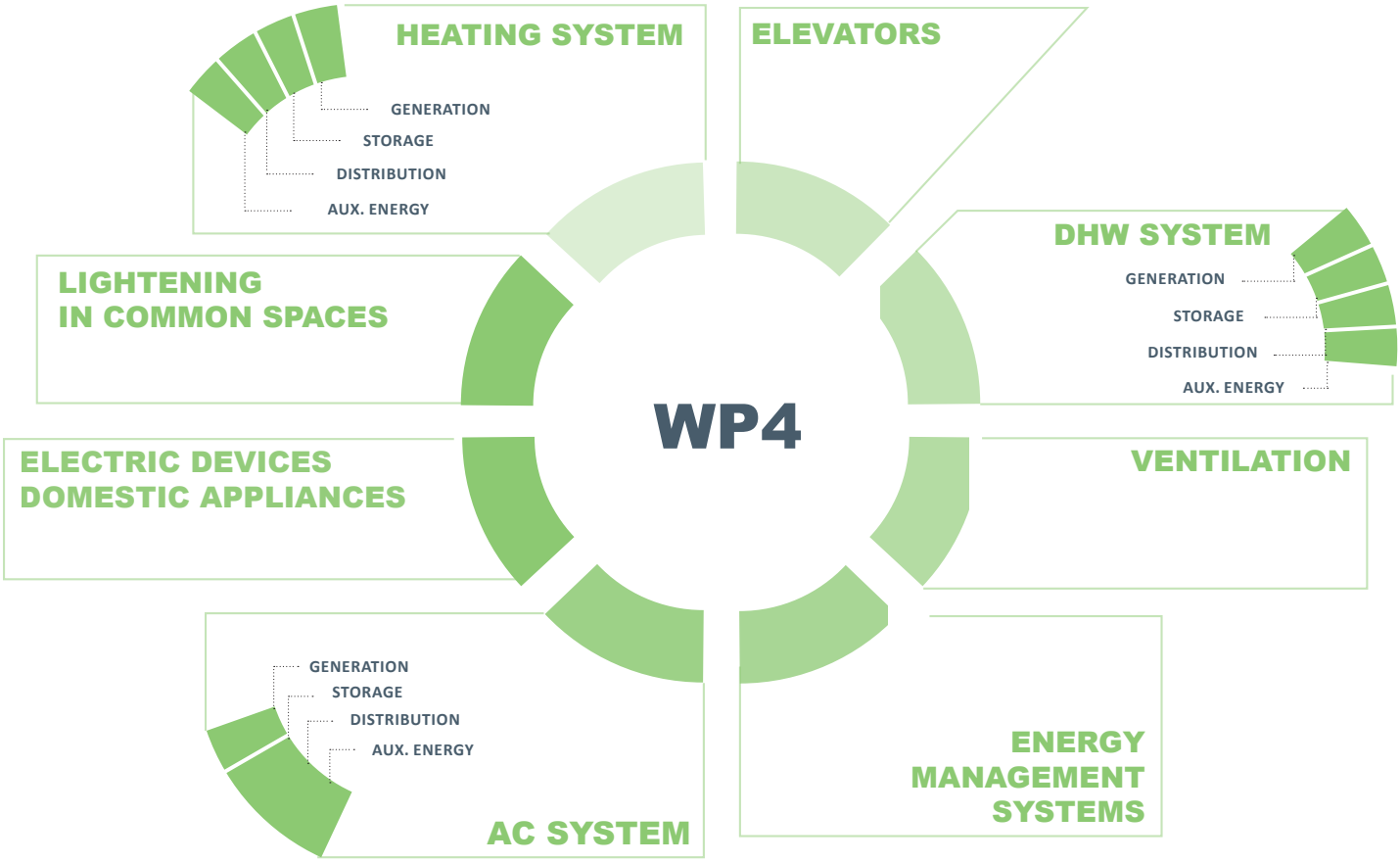
The running maintenance ESM are most of the time subcontracted to heating providers and Facility Management companies. It deals usually with low cost measures like the balance and the regulation of the heating systems, the insulation and the cleaning of the hot water pipes, the maintenance of the boilers 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.

# TYPOLOGY

## WP4 RUNNING MAINTENANCE



# TYPOLOGY
## WP4 RUNNING MAINTENANCE

### WHAT DO WE MEAN BY «MAINTENANCE OF THE HEATING SYSTEM» ?

| | |
|---|---|
| GENERATION | Replacement of the burner, cleaning boilers, boiler renovation, optimized air-to-fuel ratio, testing equipment to detect and correct air losses, smoking, un burnt fuel losses, sooting and high stack temperatures, dataloggers, detection and repair of water and air leaks, install an automatic blowdown system, check periodically the water chemistry and provide adequate water treatment, replace/clean filters, repair/replace valves, inspection and cleaning of chimney |
| STORAGE | Replacement of the warm water tank, replacement of insulation of the warm water tank |
| DISTRIBUTION | Replacement of circulation pumps, thermal insulation of heating pipes, replacement of heating unit, hydraulic balancing of the heating system, change of regulation in district heating station, replacement of pipes, detection and repair of water and air leaks, check obstructions, leaks, insulation in ducts, check/clean volume dampers, check thermostat settings |
| AUX. ENERGY | installation and use of data loggers (tracking auxiliary energies delivered to the system and optimizing the system |

### WHAT DO WE MEAN BY «MAINTENANCE OF THE EVELATORS» ?

New elevators, lift regulation (energy saving soft start kits, speed modulators, etc...)

### WHAT DO WE MEAN BY «MAINTENANCE OF THE DHW SYSTEM» ?

| | |
|---|---|
| GENERATION | Replacement of decentral instantaneous water heater, cleaning the DHW tank, cleaning/replacement of heating coil, cleaning/replacement of heating element, reduce the maximum temperature of DHW boiler |
| STORAGE | Cleaning boilers, insulate hot water tank |
| DISTRIBUTION | Hydraulic balance of DHW pipes, Install/Replace water-efficient shower/faucet heads and aerators |

### WHAT DO WE MEAN BY «MAINTENANCE OF THE VENTILATION» ?

Replacement of filters in the ventilation system, renovation of old ventilation system, measuring the pressure drop across the filter, coil cleaning, duct integrity evaluation and repairs air leaks, cleaning and repairs/replacements of disabled dampers, cleaning and lubrification of fans, straightening of flexible ducts

# TYPOLOGY
## WP4 RUNNING MAINTENANCE

### WHAT DO WE MEAN BY «MAINTENANCE OF THE ENERGY MANAGEMENT SYSTEM» ?

Calibration of sensors and actuators : outside air temperature, mixed air temperature, return air temperature, discharge or supply air temperture, coil face discharge air temperatures, condenser entering water temperature, heating water supply temperature, wet bulb temperature or RH sensors, space temperature sensors, economizer and related dampers, cooling and heating coil valves, static pressure transmitters, air and water flow rates, terminal unit dampers and flows

### WHAT DO WE MEAN BY «MAINTENANCE OF THE AIR CONDITIONING SYSTEM» ?

| | |
|---|---|
| GENERATION | Replacement of cooling system, chilled water temperature control, condenser water temperature control, check periodically the water chemistry and provide adequate water treatment, cleaning (condenser, evaporator, filters), change refrigerant, check refrigerant lines for the leaks and insulation damages |
| DISTRIBUTION | Detection and repair of leaks, repair/replacement of pumps, improvement of insulation quality, repairs of insulation |
| AUX. ENERGY | Installation and use of data loggers (tracking auxiliary energies delivered to the system and optimizing the system |

# CHECKLIST
## EXAMPLE OF ASSESSMENT INDICATORS

- ☐ time range between the interventions
- ☐ water temperature (ESMs linked with heating and hot water)
- ☐ air to fuel ratio (if need be)
- ☐ water chemistry check-in (if need be)
- ☐ pressure (if need be)
- ☐ electricity consumption for the system (if need be)
- ☐ testing material
- ☐ flow rates (for ventilation ESMs)
- ☐ heat output

# TYPOLOGY

## WP5 REPLACEMENT OF SYSTEMS

**WP5 Replacement of systems 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.**

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).

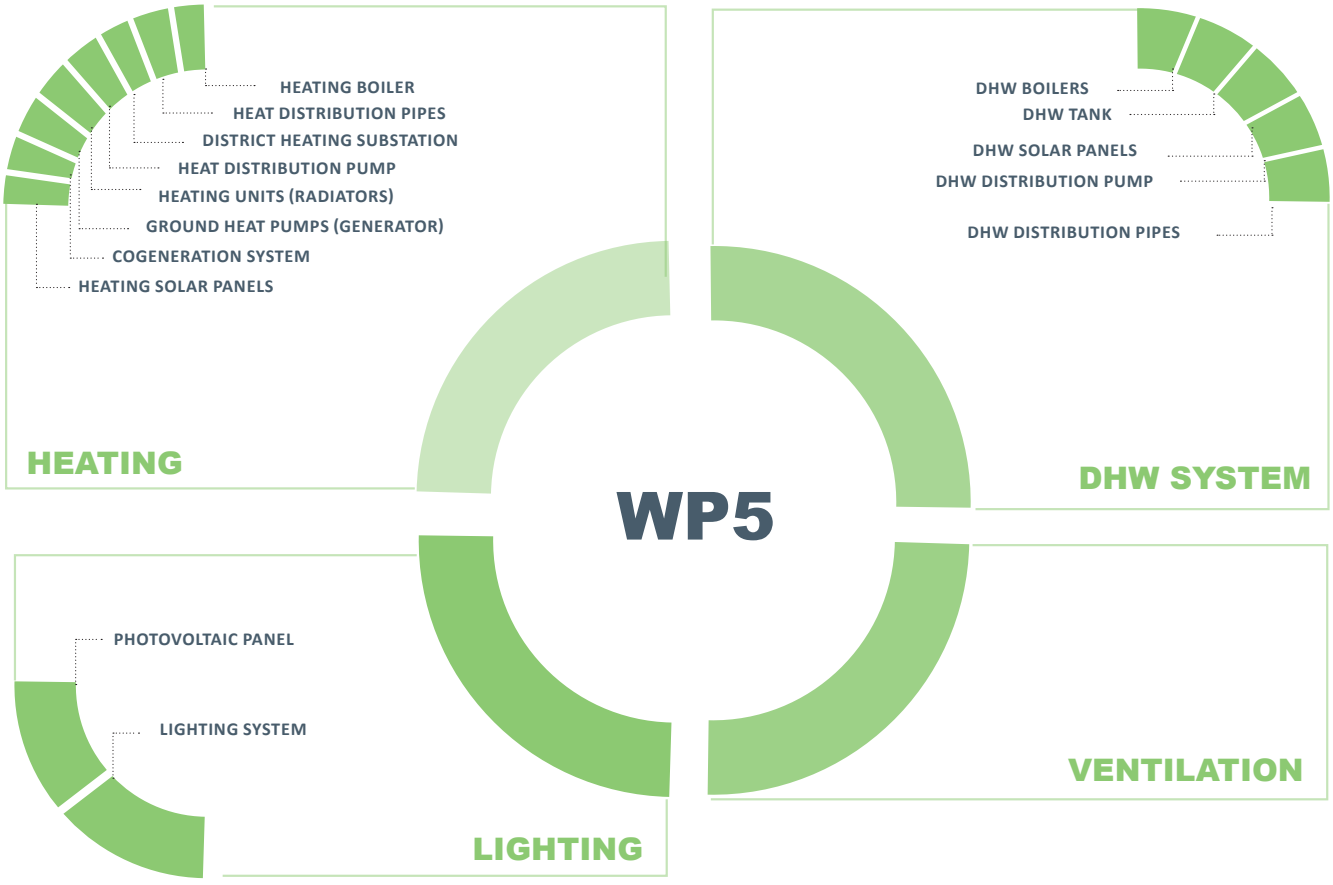
These ESM regarding systems have been separated from the ESM linked to punctual retrofitting actions as they are very different in terms of:

- 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.

# TYPOLOGY

## WP5 REPLACEMENT OF SYSTEMS



# TYPOLOGY
## WP5 REPLACEMENT OF SYSTEMS

### WHAT DO WE MEAN BY «REPLACEMENT OF HEATING SYSTEMS» ?

| | |
|---|---|
| HEATING BOILER | Old boilers replaced by new ones (conventionnal boiler to combination boiler or condensing one, steam trapping systems) |
| HEAT DISTRIBUTION PIPES | Old distribution heat pipes relaced |
| DISTRICT HEATING SUBSTATION | District heating substation replaces old boiler. Old district heating station is replaced ` with new one. One distric heating substation serving several buildings is replaced by several district heating substations. |
| HEAT DISTRIBUTION PUMP | Old distribution heat pump replaced or new one installed (coefficient of performance, new model) |
| HEATING UNITS (RADIATORS) | Old distribution heating units replaced or new ones installed (energy-saving heaters, heatkeeper materials) |
| GROUND HEAT PUMPS (GENERATOR) | Ground heat pump installed |
| COGENERATION SYSTEM | Cogeneration system installed |
| HEATING SOLAR PANELS | Solar panels for heating installed |

### WHAT DO WE MEAN BY «REPLACEMENT OF DHW SYSTEMS» ?

| | |
|---|---|
| DHW BOILER | Old boiler replaced by new one (combintion boiler, etc...) |
| DHW TANK | DHW water tank replaced by new one (from horizontal to vertical, solar water heating, different coefficient of performance) |
| DHW SOLAR PANELS | Solar panels for DHW installed |
| DHW DISTRIBUTION PUMP | Distribution water pipes replaced |

### WHAT DO WE MEAN BY «REPLACEMENT OF THE GLOBAL VENTILATION SYSTEM» ?

Old ventilators replaced or new system with heat recovery installed (insuflation, energy recovery ventilators, etc...)

### WHAT DO WE MEAN BY «REPLACEMENT OF THE LIGHTING SYSTEM» ?

| | |
|---|---|
| PHOTOVOLTAIC PANELS | Photovoltaic panels installed |
| LIGHTING SYSTEM | Replacement of lighting system (individualized commands, timers, etc...) |

# TYPOLOGY
## WP5 REPLACEMENT OF SYSTEMS

## CHECKLIST
### EXAMPLE OF ASSESSMENT INDICATORS

**«REPLACEMENT OF HEATING SYSTEM»**

- ☐ type of boiler
- ☐ energy carrier consumption
- ☐ heat output/powering
- ☐ temperature of water in the system
- ☐ polluting elements production
- ☐ electricity consumption for the system

**«REPLACEMENT OF VENTILATION SYSTEM»**

- ☐ flow rates
- ☐ humidity
- ☐ electricity consumption for the system

# TYPOLOGY
## WP6 REFURBISHED BUILDINGS

**WP6 Recently refurbished buildings 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:

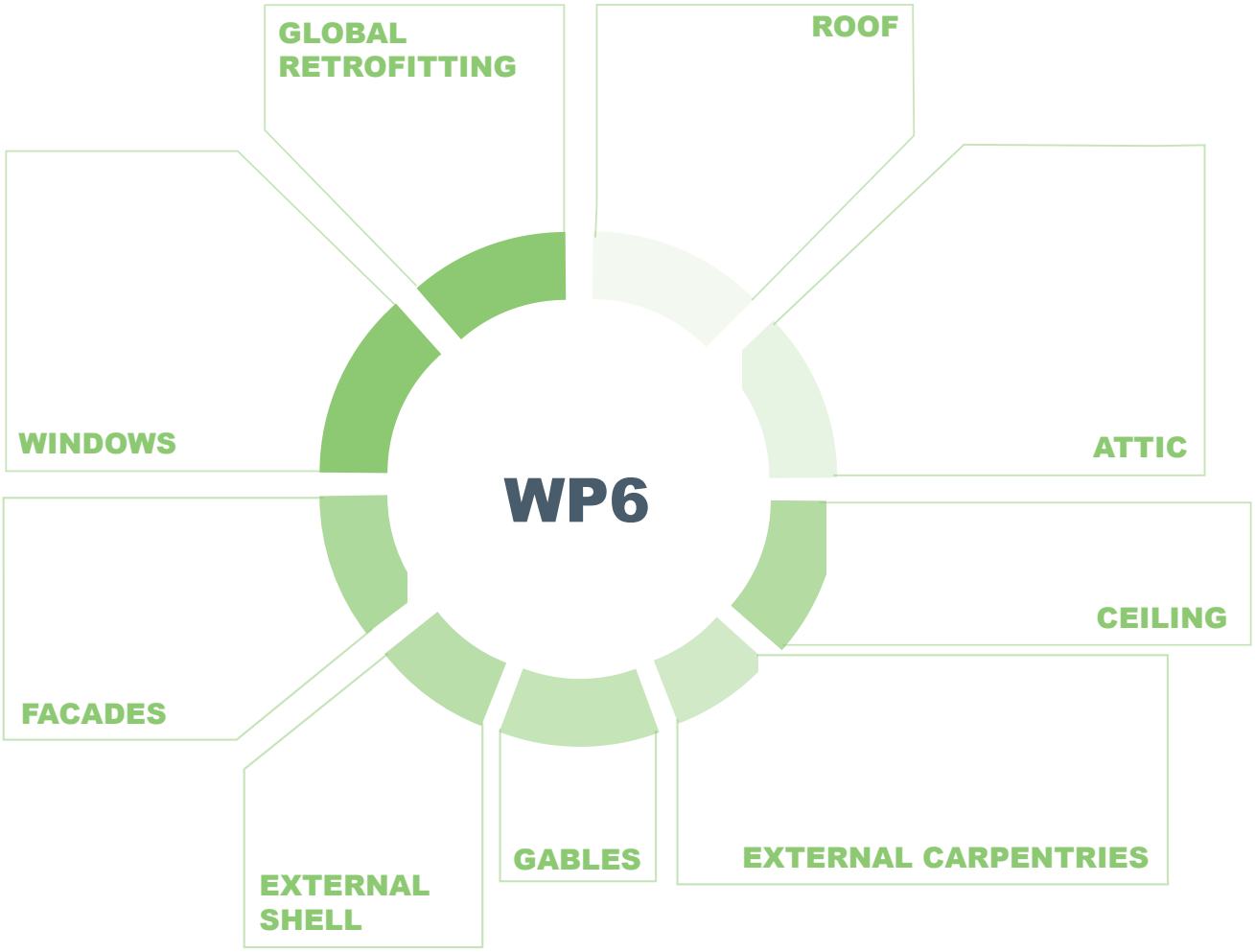
- Punctual interventions on the shell (north façade insulation, replacement of the windows, etc.) that were made without previous energy audits. These interventions were very almost systematic before the EPBD certificates but without a large scale analysis of the actual impact on the energy consumption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

Same building typologies as in WP3 will be used to segment the analysis and improve the transfer potential of the lessons learnt from these past experiences

# TYPOLOGY

## WP6 REFURBISHED BUILDINGS



# TYPOLOGY
## WP6 REFURBISHED BUILDINGS

### WHAT DO WE MEAN BY «INSULATIONS» ?

| | |
|---|---|
| ROOF | Flat roof insulation replacement. External insulation roof. Slooping roof insulation. Insulation roof. Thermal insulation of roof (materials, inverted insulations, vegetalization, etc...) |
| ATTIC | Attic insulation |
| EXTERNAL CARPENTRIES | External carpentries replacement |
| GABLES | External insulation gables |
| CEILING | Celling insulation (modus operandi et time, thermal bridge control, surface modification, etc...) |
| EXTERNAL SHELL | External shell insulation (good practices during the investment phase, maintenance of the materials, prefabricated solutions, etc...) |
| FACADES | Facades internal insulation. Insulation of the facade (14-10-30 cm) |
| EXTERNAL | External thermal insulation. External insulation/TFF2a. Externel insulation/DV45 |
| WINDOWS | New windows (frames , glazing, following of the using practices, integration of the ventilation ? |

### WHAT DO WE MEAN BY «GLOBAL RETROFITTING» ?

Total renovation - upgrading to low-energy housing

# TYPOLOGY
## WP6 REFURBISHED BUILDINGS

## CHECKLIST
### EXAMPLE OF ASSESSMENT INDICATORS

- ☐ insulation material
- ☐ insulation technique
- ☐ insulation tightness
- ☐ R-value
- ☐ thermal bridges
- ☐ humidity
- ☐ indoor temperature
- ☐ humidity
- ☐ electricity consumption for the system

# TYPOLOGY
## WP7 LOW-ENERGY BUILDINGS

**WP7 Recent low energy buildings 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 surface for heating, ventilation and hot water.**

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:

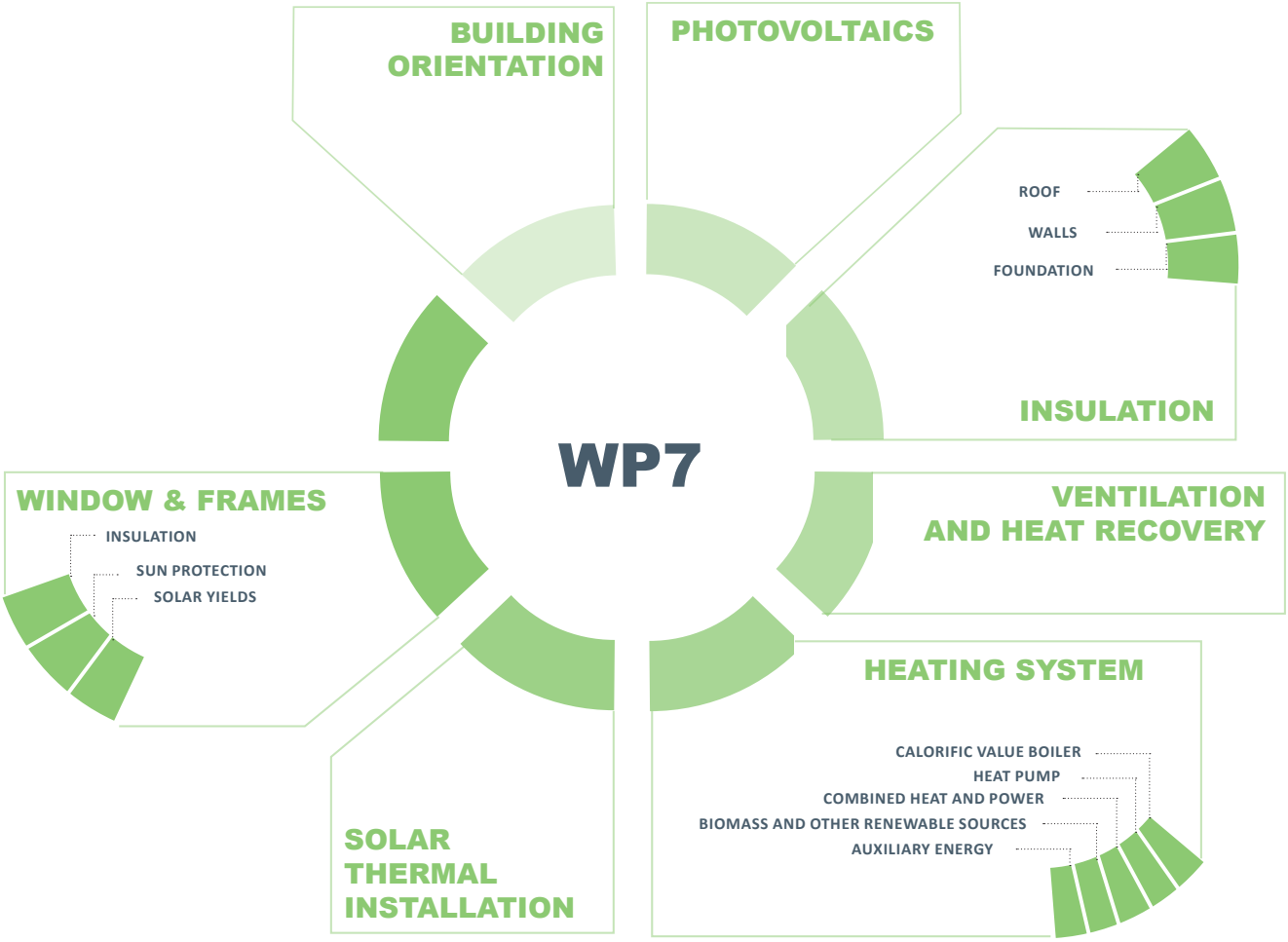
- Punctual interventions on the shell (north façade insulation, replacement of the windows, etc.) that were made without previous energy audits. These interventions were very almost systematic before the EPBD certificates but without a large scale analysis of the actual impact on the energy consumption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

Same building typologies as in WP3 will be used to segment the analysis and improve the transfer potential of the lessons learnt from these past experiences

# TYPOLOGY

## WP7 LOW-ENERGY BUILDINGS



# TYPOLOGY
## WP7 LOW-ENERGY BUILDINGS

### WHAT DO WE MEAN BY «BUILDING ORIENTATION» ?

Assessment of the building orientation effects

### WHAT DO WE MEAN BY «PHOTOVOLTAICS» ?

Assessment of the photovoltaic profitability, maintenance operations, changing pieces, etc...)

### WHAT DO WE MEAN BY «INSULATIONS» ?

ROOF

WALLS

FOUNDATIONS

Materials, Assessment of the insulation efficiency (test/solution for air leaks), inspection of the thermal enveloppe, training/formation/coordination between the different construction workers, etc...)

### WHAT DO WE MEAN BY «VENTILATION AND HEAT RECOVERY» ?

Cleaning and maintenance of the double flux ventilation, etc...

### WHAT DO WE MEAN BY «HEATING SYSTEM» ?

CALORIFIC VALUE BOILER

HEAT PUMP

COMBINED HEAT AND POWER

BIOMASS AND OTHER RENEWABLE SOURCES

AUXILIARY ENERGY

Assesment of the energy production, maintenance and control of the system, calculation of the heat from residents' bodies, tests, etc...

### WHAT DO WE MEAN BY «WINDOWS» ?

INSULATION

SUN PROTECTION

SOLAR YIELDS

Assessment of the efficiency for protection materials (insulated glazing), following of the frames implementation, blinds, optimization of the solar gain, etc...

### WHAT DO WE MEAN BY «SOLAR THERMAL INSTALLATION» ?

AUXILIARY ENERGY

Assessmentment of the efficiency for solar panels, hydrogen plants, etc...

# INVEN
# TORY

# INVEN
# TORY

# INVENTORY
## DATA COLLECTION PROCESS


**The Inventory framework has been the central tool for the data collection.**
**The Inventory framework gathers main informations regarding the economic, energy and awaraness performance of every ESMs.**
**This document is a data basis. Every SHO and NHA completed informations and facts about the different measures experimented during the last 5 years.**

**The Inventory is divided into 5 Work Packages according to the Annex I. Every indicator may not be completed and has to be foreseen according to the concerned energy saving measure. The Inventory is a first step to look for informations about ESMs and to select the most relevant ones.**

## 2. ESM ID

| n° | 2.1. SHO concerned | 2.2. Country of implementation | 2.3. Adress (locating) of the building concerned | 2.4. Year of construction of the building and implementation of the ESM | | 2.5. Building description | 2.6. Name of the ESM | 2.7. Description of the ESM | 2.8. Perimeter of the ESM | | 2.9. Surface of the ESM (m2) | 2.10. Number of years of monitoring | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Construction of building | Implementation of the ESM | | | | Number of buildings/dwellings | Number of inhabitants | | Before | After |
| | | | | | | | | | | | | | |

## 3. Main economic datas

| n° | 3.1. Cost of the investment (€) | 3.2. Additional initial costs | 3.3.1. Description of the maintenance measures | | 3.3.2. Annual cost for maintenance (€/year) | | 3.4.1. Description of the operation measures | | 3.4.2. Annual cost for operation (€/year) | | 3.5.1. Description of the management measures | | 3.5.2. Annual cost for management (€/year) | | 3.6. Payback period (years) | 3.7. Technical duration of the ESM (years) | 3.8. Annual costs for overall energy consumption (€/year) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Before | After | Before | After | Before | After | Before | After | Before | After | Before | After | | | Before | After |
| | | | | | | | | | | | | | | | | | | |

## 3. Main energy datas

| n° | 4.1.1. Overall Energy Consumption if relevant (kWh/m2.year) | | 4.1.2. Type of energy | | 4.2 Energy consumption for heating if relevant (kWh/m2.year) | | 4.3 Energy consumption for hot water if relevant (kWh/m2.year) | | 4.4. Energy for lighting of the common parts if relevant (kWh/m2.year) | | 4.5. Energy consumption for ventilation if relevant (kWh/m2.year) | | 4.6. Heating degree days of the site (D.K) | 4.7. Indoor temperature (°C) | 4.8. Overall water consumption (hot & cold) if relevant (m3) | | 4.9. CO2 emissions due to energy use in operation (kg eq CO2/year) | | 4.11. Share of renewables in overall energy consumption (% of kWh/m2.year) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After | Before | After | Before | After | Before | After | | | Before | After | Before | After | Before | After |
| | | | | | | | | | | | | | | | | | | | | |

## 4. Main awareness datas

| n° | 5.1 Complaints by tenants | | 5.2 Vacancy rate (%/year) | | 5.3. Turnover rate (%/year) | 5.4. ESM awareness concrete measures | 5.5. Cost of the ESM awareness measure | 5.6. Management measures for the ESM | 5.7. Satisfaction of the housing company regarding the ESM | Photos |
|---|---|---|---|---|---|---|---|---|---|---|
| | Before | After | Before | After | | | | | | |
| | | | | | | | | | | |

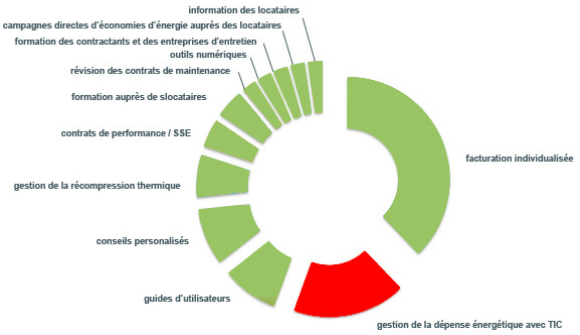
ESM NAME OF THE ESM

WP1 **WP2** WP3 WP4 WP5

CORRESPONDING WORK PACKAGE

## ESM DESCRIPTION /

### TYPE OF ESM /




### INITIAL ISSUES

## GENERIC ESM DESCRIPTION

### TECHNICAL ASPECTS

### MAINTENANCE ASPECTS

### OPERATION ASPECTS

### MANAGEMENT ASPECTS

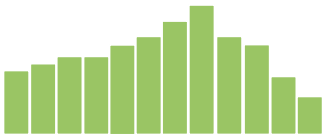
### TENANTS' EMPOWERMENT ASPECTS

## BUILDING IDENTIFICATION /


Country

City

Heating Degree Days



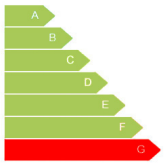
Year of construction permit /

Social Housing Compagny /

Type of building (small/big collective ; individual, etc...) /

Description of the building /

Overall energy consumption of the building before the ESM /




MAP

PHOTOS

PHOTOS

## ESM IDENTIFICATION /

| | |
|---|---|
| Year of implementation of the ESM | |
| Number of year of monitoring before | |
| Number of year of monitoring after | |
| Quality of the evaluation | |

Number of dwellings (all the building, appartment, etc...) /

percentage of dwellings in the building

Floor surface concerned by ESM ▼

Building volume concerned by ESM ▼

Number of inhabitants /

TECHNICAL ASPECTS

MAINTENANCE ASPECTS

OPERATION ASPECTS

MANAGEMENT ASPECTS

TENANTS' EMPOWERMENT ASPECTS

## INVESTMENT ASSESMENT

**QUANTITATIVE** QUALITATIVE

Cost of the investment

*Initial cost and inirial adaptation {capital expenditure}*

QUANTITATIVE **QUALITATIVE**

Additional initial costs

*staff costs, material {not capital expenditures}*

## MAINTENANCE ASSESMENT

**QUANTITATIVE** QUALITATIVE

Annual costs for maintenance

*Actual incured costs directly related to the ESM*

QUANTITATIVE **QUALITATIVE**

Maintenance measures

*Measures directly related to the ESM*

## OPERATION ASSESMENT

**QUANTITATIVE** QUALITATIVE

Annual costs for operations

*Actual incured costs directly related to the ESM*

QUANTITATIVE **QUALITATIVE**

Operation measures

*Operations directly related to the ESM*

## MANAGEMENT ASSESMENT

**QUANTITATIVE** QUALITATIVE

Annual costs for the management

*Average hourly rates per personel can be used*

QUANTITATIVE **QUALITATIVE**

Management measures and processes

## LIFETIME & COSTS ASSESSMENT

**QUANTITATIVE** **QUALITATIVE**

Amortization time

*Number of years after which the accountancy value of the measure is 0*

▼

**QUANTITATIVE** **QUALITATIVE**

Service life

▼

## ENERGY CONSUMPTION COST ASSESSMENT

**QUANTITATIVE** **QUALITATIVE**

Annual costs for overall energy consumption

▼

*Annual costs per use*

▶ type of consumption

*before* *after*

▼ ▼

▶

▶

## ENERGY CONSUMPTION

**QUANTITATIVE** QUALITATIVE

### Overall energy consumption

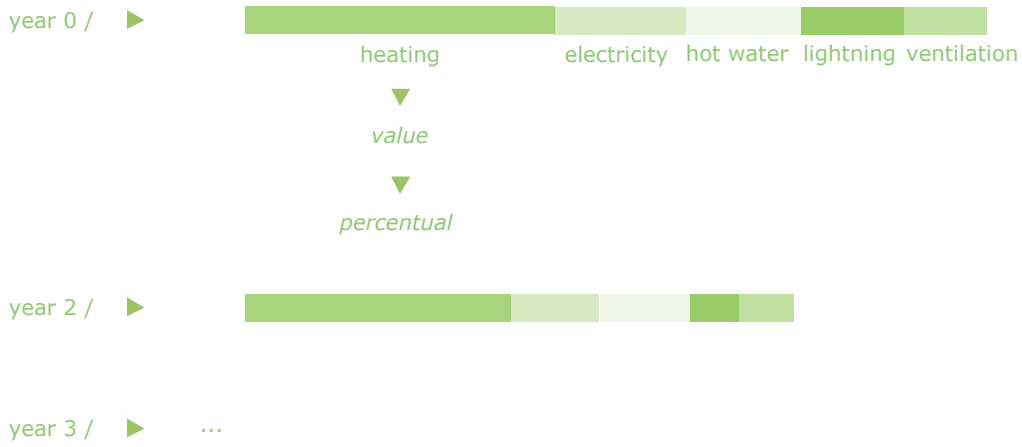
*total consumption of energy (heating/cooling, electricity, hot domestic water (HDW), ventilation and lightning*

*before* ▼ *after* ▼

**QUANTITATIVE** QUALITATIVE

### Final energy consumption per type of energy

*staff costs, material {not capital expenditures}*




**QUANTITATIVE** QUALITATIVE

### Water consumption

*Water consumption for the whole building, for the whole year*

*before* ▼ *after* ▼

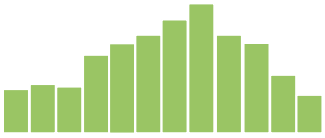
## TEMPERATURE EVOLUTION

**QUANTITATIVE** **QUALITATIVE**

### Indoor temperatures

*Average temperatures inside the flats*

year 0 / ▶



*Heating degree days*

*Indoor temperatures*

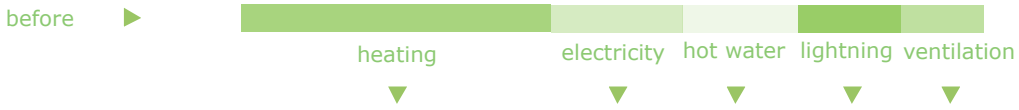
year 1 / ▶ ...

## BUILDINGS IMPACTS

**QUANTITATIVE** QUALITATIVE

### Emissions due to energy use in the operation

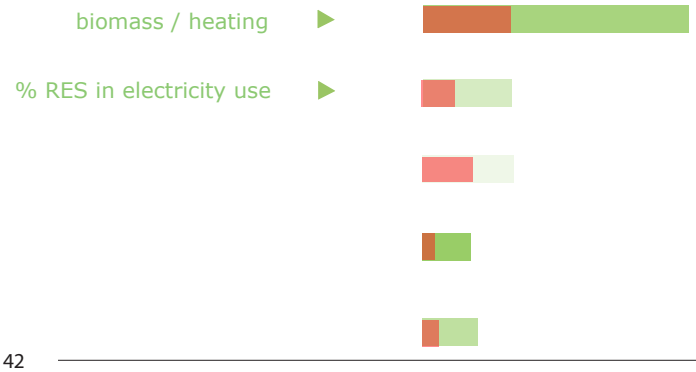
*Greenhouse gas emissions due to the measured energy consumptions*




**QUANTITATIVE** QUALITATIVE

### Emissions due to energy use in the operation

*Greenhouse gas emissions due to the measured energy consumptions*



## COMPLAINTS BY TENANTS

**QUANTITATIVE** **QUALITATIVE**

Satisfaction rate

▼

**QUANTITATIVE** **QUALITATIVE**

Collection of testimonies

▼

**QUANTITATIVE** **QUALITATIVE**

Vacancy rate

*Percentage of flats which not occupied*

*before*

▼

*after*

▼

**QUANTITATIVE** **QUALITATIVE**

Turnover rate

*Percentage per year of the total units in a social housing building that change occupants*

*before*

▼

*after*

▼

## TENANTS AWARENESS

**QUANTITATIVE** **QUALITATIVE**

Costs of awareness measures

▼

**QUANTITATIVE** **QUALITATIVE**

Costs of awareness measures

▼

## SOCIAL HOUSING ORGANIZATIONS' INVOLVEMENT

QUANTITATIVE **QUALITATIVE**

Management of the ESM

QUANTITATIVE **QUALITATIVE**

Satisfaction of the housing company

- **Name of the ESM :**

**+ WP x / Type / Subtype**

**+ Ranking**

- **Building :**

**SHO + Country :**
**Adress of the building**
**Year of construction of the building + Year of implementation of the ESM :**
**Number of dwellings :**
**Surface of the ESM :**

- **Description of the ESM :**

(Simple description of the technical aspects & process)

(O&M aspects)



- **SWOT :**

**S**trenghts

**W**eaknesses

**O**pportunities

**T**hreats

## Evaluation :

(Assessment according to personal experience, professional knowledge and results of the Inventory)

Scale

- not relevant / reject
- not a priority
- neutral
- interesting investment (punctual implementation)
- prioritary (to be generalized)

### Economic interest

(The assessment has to be done regarding the initial investment costs, the additional O&M costs and the payback period)

Assessment

Remarks

### Energy interest

(The assessment has to be done regarding the percentage of primary energy savings ponderated by HDD)

Assessment

Remarks

### Social interest

(The assessment has to be done globally regarding both the user-friendly potential of the ESM and its economic impact on the tenants' invoice (sum rent + charges)

Assessment

Remarks

## Optimization clues :

→ Technical improvements (description/potential costs/complementary performance)

→ O&m improvements (description/potential costs/complementary performance)

# HAND BOOK

# HAND BOOK

# SUMMARY

# HANDBOOK
## INTRODUCTION


**The AFTER Handbook is the starting point of the AFTER global methodology .**
**This Handbook will be used in the Inventory phase in order to deliver an ID for the different ESMs collected by the partners and to present some of the specificities regarding ther implementation.**

**The Handbook will be then completed regarding the characteristics of the 18 Pilot ESMs. These characteristics will be linked with the identification of the ESMs and of the indicators aiming at precising their criteria of efficiency.**

### 0.1. CONCEPTUAL FRAMEWORK

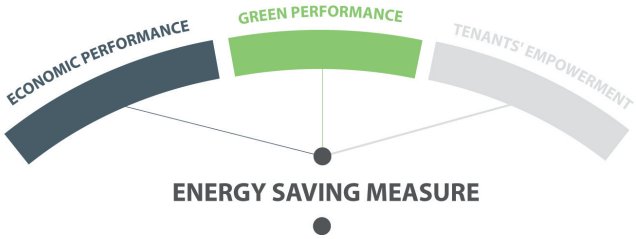
The common conceptual framework has the purpose to set the frame for a simultaneous assessment of the economic, environmental and social impact of Energy Saving Measures (ESM's), experienced by the Social Housing Organisations (SHO's) during the last five years.

The conceptual framework consists of
1. **An Inventory template** will provide to the partners a framework to register the data of the ESMs informing various performance indicators for the assessment of the economic, environmental and social impact of the ESMs.
2. **A Handbook** will offer definitions of the performance indicators (perimeter, metering units,...) to secure the comparability of the ESMs' performances and the scientific quality of the evaluation of ESM.
This Handbook will be completed in a first time, with the most important elements to complete in order to identify ESMs and some clues on the characteristics of the different WPs.
After the selection of the Pilot ESMs, this Handbook will be completed with specific indicators related to the ESMs the project will focus on. This step will be accomplished at the same the SHOs will proceed the evaluation of the measures.
As AFTER covers a diversity of investments, interventions and actions, the Handbook is a work-in-progress that will be updated regarding how the project will evolve.
This Handbook is giving the specification of the perimeter, metering units, nature and specific remarks to the ESMs to help the data finding. Its structure follows the Inventory frame.
3. **Typology lists** will present an overview of generic ESMs within the five focus areas: Management of the housing stock, operation and maintenance of the building stock, system replacement, retrofitting and new housing
4.**Factsheets** will gather the information collected on AFTER ESMs.

# HANDBOOK
## INTRODUCTION

### 0.2. GLOBAL PERFORMANCE INDICATORS FOR ESMs

The global performance indicators analyze economic, energy and social perdormance of every ESM and presents a comparable overview.
The objective is to obtain at the end of the implementation process a global understanding of one ESM efficiency.
Even if some qualitative information will improve and get more content for every ESM implemented, the AFTER Project focuses on 3 main range of indicators.




Everyone of these global indicators are corresponding to one ambition. They will be completed during the process, if need be, by other indicators more adapted to the specific context and content of everyone of the selected Pilot ESMs.

**Economic performance**

The economic efficiency is related to a global estimation of the costs impact for the implementation of an ESM and its benefits on the energy consumption.

This economic efficiency will be mainly informed and assessed thanks to two facts:

-the costs linked to the investment and the O&M costs linked with the investment
-the costs linked to the specified energy consumption.

These two battery of data can help us to determine the payback period that can be defined by the time it takes to cover initial costs. It can be calculated from the number of years elapsed between the initial investment, its subsequent operating costs and the time at which cumulative savings of ESM offset initial costs.

When there isn't any investment such as it appears most of the times in WP3 and WP4, it is suggested to give an economic value (additional initial cost in the inventory template) of the time spent to plan the ESM.

To be able to compare across countries, the payback period should be calculated.  See calculation tool enclosed in Annex D in the Handbook.

**Energy performance – overall energy consumption per m2 per year**

Overall consumption is defined as the total consumption of final energy – the summary of delivered energy by all energy carriers excluding individual electricity.
Meter readings from the flats are used as the basis for the data finding.
As a AFTER mainly focus on the impact of energy saving measures related to the heating and the hot water, the indicators used to assess the energy performance will be mainly consumption in kWh and m3.

**Social performance – tenants awareness**

The social performance indicator may be the most complicated impacts to assess. They both cover qualitative and quantitatives impacts.
Quantitative data are classic indicators used in the social housing to identify to follow their tenants' satisfaction and mobility .These indicators can only be corrected and completed with qualitative data based on the direct testimony of the tenants.

# HANDBOOK
## GENERAL REMARKS

**General criterias propose simple features regarding in order to elaborate a simple ID for Energy Saving Measures.**
**The objective is to have the same unity counting regarding scales of measurement that will be developed in the second part of the Handbook.**

### 1.1 Floor area

In determining the definition : conditionned reference floor area is used (reference: EU-project TABULA)

cf. Illustration in Annex E

| Name | Description |
|---|---|
| **conditioned reference floor area** | **General remark: «conditioned» building area (or building volume) refers here and in the following to that part of a building which is supplied by a heating system and/or an air-conditioning system. (air-conditioning means here at least cooling, not only ventilation)** |
| conditioned gross floor area | Conditioned floor area calculated on the basis of external dimensions (measured to the outside surface of external walls) |
| conditioned floor area | Conditioned floor area calculated on the basis of internal dimensions (measured to the inside surface of external walls)<br>The floor area may be the gross internal area (= total building area measured inside external walls) or the net internal area (= total building area measured inside external and internal walls) - since the difference is small we don't distinguish between both.<br>The conditioned area is generally equal with the heated area or with the air-conditioned area, dependend of which is the bigger one. |
| conditioned useful floor area | Section of the conditioned net floor area primarily dedicated to the utilisation of the building, excluding functional and circulation areas (excluding e.g. stair cases in all buildings, corridors in non-residential buildings).<br>In office buildings the conditioned useful floor area is equivalent to the net lettable area. |

# HANDBOOK
## GENERAL REMARKS


### 1.2 Currency

All costs should be in Euro. For countries outside the Eurozone, a unique conversion rate shall be applied for all figures (http://ec.europa.eu/budget/inforeuro/index.cfm?Language=en – chose year: 2011 and month: 5 – the beginning of the project.

All costs should exclude taxes (if your company can recover it if not, include it).

### 1.3 Quality of the data

Estimations and calculated values are written in cursive.

In the Handbook it is stated if the ESM is qualitative or quantitative. Qualitative means a subjective judgement e.g. descriptions. Quantitative is measured or counted data.

### 1.4 Perimeter of the energy performance

As a rule the considered energy services for energy rating are: heating; cooling and dehumidification; ventilation and humidification; hot water; lighting (optional for residential buildings when energy consumption is calculated, included if metered); other services (optional when energy consumption is calculated, included if metered).

If only the figures for the difference between before and after of a certain ESM is available, it is also OK (e.g.: extra maintenance costs due to new ventilation system). Then it is important to make a remark of the actual perimeter (e.g.: overall maintenance costs). See also 2.8.

### Additional remark (after the Inventory phase):

*The data battery developed during the Inventory phase can be considered as to exhaustive regarding the organizational routines of the Social Housing Organizations.*

*The Perimeter of Energy saving Measures regarding management and maintenance of the Social Housing companies should mainly focus on the heating and hot water consumption as these two elements represent the major part of the consumption in buildings.*
*As a consequence, it will seem more relevant to focus for the Social Housing Organizations (SHOs) which would like to implement of AFTER-like approach to identify as priority these two perimeters of energy performance and avoid to focus on more minor savings (lighting, elevators, etc.).*

# HANDBOOK
## ENERGY SAVING MEASURES ID

**Energy Saving Measures IDs include simple elements to collect regarding the situation of the SHO and the description of the ESM. The framework will be the same for every ESM and will allow to highlight the necessary elements to understand an energy saving measure, its context and objectives.**

### 2.1. Social Housing Organization concerned

- Legal name of the SHO responsible for the ESM.

### 2.2. Country of implementation

- Home country of the SHO / ESM.

### 2.3. Address (location) of the building concerned

- Home address / location of the building(s) / ESM.

*Geographical location of the building is useful for the determination of the geographical reference for e.g. the Heating Degree Days.*

### 2.4. Year of construction of the building and implementation of the ESM

- When was the building constructed (year of the beginning of the construction)
- When has the ESM been implemented (year of implementation)?

*The first year of ESM operation (commissioning) shall be considered. In general, this shall not be before 2006.*

### 2.5. Building description

A short description of the building should contain:

- typological and quantitative instructions in order to identify what kind of residential building we are focused on number of flats, floors, cellar, roof, balconies (add a picture, but remember copy rights)

- a description of the materials and systems related with the potential ESM impact or implementation (*roof, walls, foundation, windows & frames, sun protection, heating (/cooling) system and energy carrier, solar thermal installations, photovoltaics, ventilation and heat recovery*).

## 2.6. Name of the ESM

Use a simple a descriptive name for the ESM refering to the typology lists provided by every WP leaders. The name of the ESM should give a first global information on the objectives and part of the building impacted by the ESM implementation.

## 2.7. Description of the ESM

Describe technical/operational/concrete aspects of the measure:

- what part of the building or its management is impacted ?
- who implements / operates it?
- how does it work
- what are the expected results?

*Typologies provided by the scientific WP leaders will propose a framework to lead SHOs in their descriptions.*

## 2.8. Perimeter of the ESM

In the Inventory, the perimeter of the ESMs is defined:

-the number of buildings/dwellings concerned by the ESM
-the number of inhabitants. .

*Then the measurement boundary of the savings determination will be more specific. The boundary may be as narrow as the flow of energy through a pipe or wire (part of facility), or as broad as the total energy use of one or many buildings. (entire facility)*

## 2.9. Area of the ESM

Floor area which match the perimeter of the ESM.

*See 1.1 Surface for the right definition of the surface.*
*Note the area + area type (see 1.1) and heated or ventilated area (see 1.2).*

## 2.10. Period of monitoring

The time period, number of years on which the data is based, shall be specified.

*If several years of monitoring are available, give all these gross values (no average and without any correction).*
*The time period should be at least one year – better more.*

# HANDBOOK

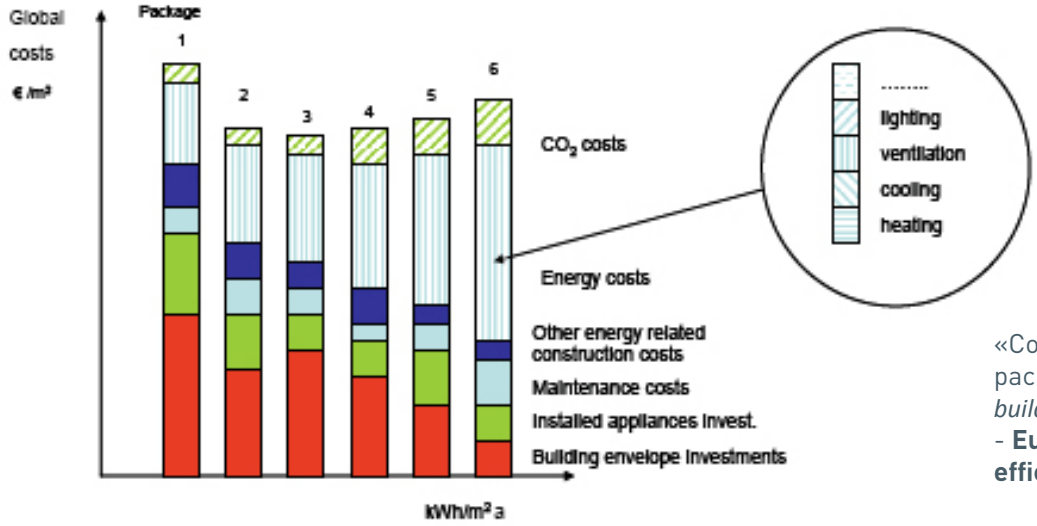
# INDICATORS FOR ECONOMIC PERFORMANCE ASSESSMENT ON COMMON MEASURING UNITS

**The indicators for economic performance should indicate the life cycle costs for an ESM within its perimeter.**
**AFTER mainly aims at identify the private cost efficiency of an ESM for a Social Housing Company.**

**Cost calculation differs from one country to another and from one SHO to another (interest rates, cost of energy, legal financing, etc...). The objective of the Inventory is mainly to manage to identify relevant indicators regarding the costs able to assess the efficiency of one measure.**

Global costs for an ESM can be identified regarding several aspects.
The AFTER project will mainly focus on three aspects to identify the economic efficiency of one investment:

- the original financial investment required by the implementation of the Energy Saving Measures.
- the maintenance and operational costs linked with the ESM and their ammount which allow us to see what is the cost of an ESM during its life cycle.
- the energy costs impacted by the ESM which translate the cost impact of the savings linked with the implementation of an ESM.




«Cost calculation of different packages» from *Cost Optimal building performance requirements* - **European council for an energy efficient economy.**

# HANDBOOK
# INDICATORS FOR ECONOMIC PERFORMANCE ASSESSMENT ON COMMON MEASURING UNITS

## 3.1. Cost of the investment

**Nature**
Quantitative / Qualitative

**Metering Unit**
euros

**Specifications & perimeter**
Capital cost (ISO 15686-5)
*"Initial cost and cost of initial adaptation where these are treated as capital expenditure"*

**Remarks from the WP's**
WP4: Maintenance is not an investment = 0

## 3.2. Additional initial costs

**Nature**
Quantitative / Qualitative

**Metering Unit**
euros

**Specifications & perimeter**
Other initial costs that are not treated as capital expenditure (staff cost, material,...).

**Remarks from the WP's**
WP4: No additional costs for maintenance as is not an investment = 0

## 3.3. Maintenance of the ESM

### 3.3.1. Description of the maintenance measures

**Nature**
Quantitative / Qualitative

**Specifications & perimeter**
Describe the maintenance measures and processes directly related to the ESM.
Maintenance is described in the following indicator 3.3.2.

**Remarks from the WP's**
No remarks

### 3.3.2. Annual costs for maintenance [Before] & [After]

**Nature**
Quantitative / Qualitative

**Metering Unit**
euros/year

**Specifications & perimeter**
ISO 15686-5
*"Total of necessarily incurred labour, material and other related costs 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)".*

These costs only include the annual maintenance costs directly linked to the ESM assessed.

**Remarks from the WP's**
Include regular and periodic maintenance, maintenance management cost, annualized replacement cost.
WP4: If e.g. boilers are cleaned every four years, the cost would be 100/4=250 Euro per year in annual costs for maintenance.

# HANDBOOK
# INDICATORS FOR ECONOMIC PERFORMANCE ASSESSMENT ON COMMON MEASURING UNITS

## 3.4. Operation of the ESM

### 3.4.1. Description of the operation measures

**Nature**
Quantitative / Qualitative

**Specifications & perimeter**
Describe the operation measures and processes directly related to the ESM.
Operation is described in the indicator 3.4.2.

**Remarks from the WP's**
No remarks

### 3.4.2. Annual costs for operation [Before] & [After]

**Nature**
Quantitative / Qualitative

**Metering Unit**
euros/year

**Specifications & perimeter**
Cf. 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)".*

These costs only include the annual operation costs directly linked to the ESM assessed.

**Remarks from the WP's**

No remarks.

## 3.5. Management of the ESM

### 3.5.1. Description of the management measures

**Nature**
Quantitative / Qualitative

**Specifications & perimeter**
Describe the management measures and processes directly related to the ESM.
Other management actions that are not described as maintenance and operation costs: contracting, training, communication, internal & external control, follow-up of the ESM,...

**Remarks from the WP's**
No remarks

### 3.5.2. Annual costs for the management [Before] & [After]

**Nature**
Quantitative / Qualitative

**Metering Unit**
euros/year

**Specifications & perimeter**
Other management costs not included in maintenance and operation costs (contracting, training, communication, control, marginal overhead).

These costs only include the annual management costs directly linked to the ESM assessed.

Average hourly rates per personnel category can be used for simplification. It might be an estimate.

**Remarks from the WP's**
No remarks

# HANDBOOK
# INDICATORS FOR ECONOMIC PERFORMANCE ASSESSMENT ON COMMON MEASURING UNITS

## 3.6. Pay back period

**Nature**
Quantitative / Qualitative

**Metering Unit**
Years

**Specifications & perimeter (will eventually be calculated by WP leaders, but data are needed)**
The payback period can be defined by the time it takes to cover initial costs. It can be calculated from the number of years elapsed between the initial investment, its subsequent operating costs and the time at which cumulative savings of ESM offset initial costs.

When there isn't any investment such as it appears most of the times in WP3 and WP4, it is suggested to give an economic value (additional initial cost in the inventory template) of the time spent to plan the ESM.

Alternatively – and to be able to compare across countries - the pay back period can be calculated. See calculation tool in ANNEX D.

**Remarks from the WP's**
No remarks

## 3.7. Technical duration of the ESM

**Nature**
Quantitative / Qualitative

**Metering Unit**
Years

**Specifications & perimeter**
Service life of the ESM as given by the constructor if existing or estimated by the producer, or it can be taken from EN 15459: 2007 Heating systems in buildings - Data requirements for standard economic evaluation procedures related to energy systems in buildings, including renewable sources (ANNEX A + B).

**Remarks from the WP's**
Not relevant for WP3 and 4

## 3.8. Annual costs for overall energy comsumption [Before] & [After]

**Nature**
Quantitative / Qualitative

**Metering Unit**
euros

**Specifications & perimeter**
This indicator is broken down in 2 similar indicators for the following phases:

- the period before the implementation of the ESM
- the period after the implementation of the ESM.

Uses included shall be the same as the ones included in the energy consumption.
Annual cost of standing charge, annualized connection charge, consumption, tax excluding VAT.

If several years of metering are available, give all these gross values (no average and without any correction).

**Remarks from the WP's**
Uses included shall be the same as the ones included in the energy consumption. Annual cost of standing charge, consumption, tax excluding VAT.

# HANDBOOK
# INDICATORS FOR ENERGY PERFORMANCE ASSESSMENT ON COMMON MEASURING UNITS

**The indicators for energy performance give us information regarding the energy consumption for a building or a group of buildings.**
**These energy consumption indicators are detailled regarding the different consumptions of a building.**

**Basis for adjustment are also develop in order to adapt these consumption data regarding the local context and to compare them.**

## 4.1. Energy consumption

### 4.1.1 Overall Energy Consumption [Before] & [After]

**Nature**
Quantitative / Qualitative

**Metering Unit**
kWh of final energy /m2 / year

**Specifications & perimeter**
Overall energy consumption per m2 per year.

Overall energy consumption is defined as:
Total consumption of final energy – summary of delivered energy by all energy carriers excluding individual electricity. Use meter readings from the flats.

For additional clarification, please refer to EN 15603: 2008, where the considered energy services for energy rating are: heating; cooling and dehumidification; ventilation and humidification; hot water; lighting (optional for residential buildings when energy consumption is calculated, included if metered); other services (optional when energy consumption is calculated, included if metered).

If the final energy consumption per particular energy carrier is metered in units other than kWh (m3, liters ...) then the caloric values of energy carriers defined within the national EPBD based regulation have to be used.

The indicator is broken down in 2 similar indicators for the following phases: the period before the implementation of the ESM and the period after the implementation of the ESM.

If several years of metering are available, give all these gross values (no average and without any correction). In this overall consumption are counted the total consumption of energy (heating/cooling, electricity, hot domestic water (HDW), ventilation and lightning of the common areas).

**Comment**
This indicator is based on metered energy data (the calculated values are used when/where the metered data are missing).

If only one meter (i.e electricity meter) is used to measure the energy consumption for more services, like: lighting, domestic hot water and other services incl. elevator, cleaning..., then the complete readings are to be used, and the same services must be covered in »before« and »after« energy indicators in order to maintain the comparability of before and after indicators.

Energy uses for lighting of flats and other services may be included in the indicators if their exclusion is not technically possible.

Detailed description of the services covered with the given energy indicators must be provided.

**Remarks from the WP's**
WP7: Benchmark: 50 kWh of final energy /m2 of living area /year. Second best option: national standard

#### 4.1.2 Type of energy

**Nature**
Quantitative / Qualitative

**Metering Unit**
kWh of final energy /m2 / year – by the type of energy

**Specifications & perimeter**
Overall consumption of final energy for heating for a whole year. The indicator is broken down in similar indicators for the following types of energy: electricity, gas, HO (Heating Oil), district heating, other (to specify).
If several years of metering are available, give all these gross values.

**Remarks from the WP's**
No remarks

### 4.2. Energy consumption for heating [Before] & [After]

**Nature**
Quantitative / Qualitative

**Metering Unit**
kWh of final energy /m2 / year

**Specifications & perimeter**
The consumption of final energy for heating for a whole year. If several years of metering are available, give all these gross values.
The indicator is broken down in 2 similar indicators for the following phases: the period before the implementation of the ESM and the period after the implementation of the ESM.

**Remarks from the WP's**
WP4: Can be obtained by reading heatmeters or can be extracted from the invoices

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# INDICATORS FOR ENERGY PERFORMANCE ASSESSMENT ON COMMON MEASURING UNITS

## 4.3. Energy consumption for Domestic Hot Water [Before] & [After]

**Nature**
Quantitative / Qualitative

**Metering Unit**
kWh of final energy /m2 /year

**Specifications & perimeter**
Consumption of final energy for the production of domestic hot water for a whole year. If several years of metering are available, give all these gross values.
The indicator is broken down in 2 similar indicators for the following phases: the period
before the implementation of the ESM and the period after the implementation of the ESM.

**Remarks from the WP's**
WP4: Can be obtained by reading heatmeters or can be extracted from the invoices

## 4.4. Energy for lighting of the common parts [Before] & [After]

**Nature**
Quantitative / Qualitative

**Metering Unit**
kWh of final energy /m2 /year

**Specifications & perimeter**
Consumption of final energy for lighting of the common parts for a whole year. If several years of metering are available, give all these gross values.
The indicator is broken down in 2 similar indicators for the following phases: the period before the implementation of the ESM and the period after the implementation of the ESM.

**Comment**
If the electricity meter covers the energy use for lighting and other common services, and if the share of energy consumption for lighting of common areas is not known, the total electricity consumption may used for this indicator, provided that the same principle is used for "before" and "after" case.
Please always provide the detailed comments on the services covered with the particular indicator.

It makes sense to use this approach only when the consumption other than lighting is more or less the same before and after (for example: common metering for lighting in common spaces+elevator+1 plug mostly used for grass cutting machine.)

**Remarks from the WP's**
No remarks

## 4.5. Energy for ventilation [Before] & [After]

**Nature**
Quantitative / Qualitative

**Metering Unit**
kWh of final energy /m2 /year

**Specifications & perimeter**
Consumption of final energy for ventilation system (if existing) for a whole year. If several years of metering are available, give all these gross values.
The indicator is broken down in 2 similar indicators for the following phases: the period before the implementation of the ESM and the period after the implementation of the ESM.

**Remarks from the WP's**
WP4: Not relevant for e.g. boiler cleaning

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# INDICATORS FOR ENERGY PERFORMANCE ASSESSMENT ON COMMON MEASURING UNITS

## 4.6. Heating Degree Days

**Nature**
Quantitative / Qualitative

**Metering Unit**
Kelvin (or degree Celsius)

**Specifications & perimeter (will be calculated by WP leaders)**
Degree days are needed for the assessment of the ESM respectively its energy comsumption in its own context (has it been an extraordinary year?) or to compare with other countries.

A degree day is computed as the integral of a function of time that generally varies with temperature. The function is truncated to upper and lower limits. Heating degree days (HDD) are defined relative to a base temperature - the outside temperature above which a building needs no heating.

We will use the same database for the united HDD of each site: www.degreedays.net
1/ Go on http://www.degreedays.net/
2/ Enter the nearest weather station ID
3/ Select «heating» for the Degree day type
4/ Select «Celsius» for Temperature Units
5/ Select national base temperature and do not select «Include base temperature nearby»
6/ Select «Average» as breakdown
7/ Select «5 years» for the period covered or the longest period possible if the station has not been working for the 5 last years
8/ Generate degree days and download the excel files, the figure that shall be used is the total one

Consumptions will be adjusted thanks to the HDD calculation model which allow to compare a baseline consumption to another reporting period using a temperature coefficiency. Savings will be calculated and highlighted thanks the adjustment of the Heating Degree Days.

The formula used in the AFTER Project is the following one:

$$C_{adj} = C_{met} * \{DD_{stand} / DD_{met}\}$$

using:

$C_{adj}$
= consumption data temperature adjusted.

$C_{met}$
= consumption data in the reporting period.

$DD_{stand}$
= number of degree days of the standard period.

$DD_{met}$

= number of degree days in the

**Remarks from the WP's**
No remarks

## 4.7. Indoor temperatures

**Nature**
Quantitative or Qualitative

**Metering Unit**
Degree Celsius (°C)

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# INDICATORS FOR ENERGY PERFORMANCE ASSESSMENT ON COMMON MEASURING UNITS

**Specifications & perimeter**
In a general way, the indoor temperature is the average level of temperature inside the flats during the heating season. This indicator will be evaluated as a qualitative or a quantitative depending on the project phase.

For both inventory and assessment phases, the average level of temperature inside the flat will be estimated by the SHOs. If the SHOs are not able to provide an average level of temperature resulting for example from internal surveys or national social housing associations, the default value of indoors temperature before and after ESM will be assigned at 20°C.

For testing phase, indoor temperatures will be evaluated if it is quite possible, for each flat and each room of the flat (bedrooms, kitchen, livingroom,...). Moreover, if there is some intermittence, two different indoor temperatures could be defined respectively for both occupancy and unoccupancy periods. For example: in the living room the indoor temperature is 21 from 7:00 AM to 10:00 PM and 19 for the rest of the time. Based on the temperature pattern an average temperature in the flat within the heating season will be defined.

Those indoors temperatures will be collected:
- as a qualitative way using dedicated surveys. The resulting temperatures will then estimated by the tenants
- as a quantitative way using temperature measurements. It is recommended to use temperature data loggers to record the temperature data. Data loggers are available to monitor a wide range of parameters such as temperature, humidity, voltage and current. Data is transferred to a PC with an USB or serial cable. A range of wireless data loggers are also available.

The position of thermometer or sensor should be defined like 1 m above the floor level , opposite wall to the window or similar.
- as a qualitative way using dedicated surveys. The resulting temperatures will then be estimated by the tenants

**Remarks from the WP's**

No remarks

## 4.8. Overall water consumption [Hot] & [Cold]

**Nature**
Quantitative / Qualitative

**Metering Unit**
m3 /year

**Specifications & perimeter**
Water consumption for the whole building and for a whole year.

The indicator s broken down in 2 similar indicators for the following phases: the period before the implementation of the ESM and the period after the implementation of the ESM.

**Remarks from the WP's**
No remarks

## 4.9. CO2 Emissions due to energy use in operation [Before] & [After]

**Nature**
Quantitative / Qualitative

**Metering Unit**
Kg of equivalent CO2 / m² / year

# HANDBOOK
# INDICATORS FOR ENERGY PERFORMANCE ASSESSMENT ON COMMON MEASURING UNITS

**Specifications & perimeter (will be calculated by the WP leaders)**
Greenhouse gas emissions due to the measured energy consumptions. It is a direct conversion of the overall final energy consumptions depending on the types of energies and the national conversion factors (in particular for the electricity. Standard emission factor for consumed electricity in EU Countries are given in the bellow table Source: EC, How to develop a sustainable energy action plan (SEAP) – guidebook, 2010, Table 5, p. 63, www.eumayors.eu).

Perimeter: limited to the uses concerned by the measure.

CO2 emissions to be calculated:
Fuel weight (kg) x net calorific value MWh/kg x carbon dioxide emission factor x (1-unburnt carbon content)

**Remarks from the WP's**
No remarks

## 4.10. Environmental impacts of building materials used for renovation of the thermal envelope

**Nature**
Quantitative / Qualitative

**Metering Unit**
Text – stating if you have considered the environmental impact of building materials.

**Specifications & perimeter**
The purpose of this indicator is to present the environmentally conscious selection of building materials / construction products used for the energy restoration of the building envelope and the building as a whole, respectively (depend on the type of ESM).

**TABLE 5. NATIONAL AND EUROPEAN EMISSION FACTORS FOR CONSUMED ELECTRICITY**

| COUNTRY | STANDARD EMISSION FACTOR (t $CO_2$/$MWh_e$) | LCA EMISSION FACTOR (t $CO_2$-eq/$MWh_e$) |
|---|---|---|
| Austria | 0.209 | 0.310 |
| Belgium | 0.285 | 0.402 |
| Germany | 0.624 | 0.706 |
| Denmark | 0.461 | 0.760 |
| Spain | 0.440 | 0.639 |
| Finland | 0.216 | 0.418 |
| France | 0.056 | 0.146 |
| United Kingdom | 0.543 | 0.658 |
| Greece | 1.149 | 1.167 |
| Ireland | 0.732 | 0.870 |
| Italy | 0.483 | 0.708 |
| Netherlands | 0.435 | 0.716 |
| Portugal | 0.369 | 0.750 |
| Sweden | 0.023 | 0.079 |
| Bulgaria | 0.819 | 0.906 |
| Cyprus | 0.874 | 1.019 |
| Czech Republic | 0.950 | 0.802 |
| Estonia | 0.908 | 1.593 |
| Hungary | 0.566 | 0.678 |
| Lithuania | 0.153 | 0.174 |
| Latvia | 0.109 | 0.563 |
| Poland | 1.191 | 1.185 |
| Romania | 0.701 | 1.084 |
| Slovenia | 0.557 | 0.602 |
| Slovakia | 0.252 | 0.353 |
| **EU-27** | **0.460** | **0.578** |

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# INDICATORS FOR ENERGY PERFORMANCE ASSESSMENT ON COMMON MEASURING UNITS

The environmental conscientious is expressed through the list of indicators of environmental impacts given in Environmental Product Declarations – EPDs for construction products. EPDs reflects the impacts of a product during its production (craddle to gate), following ISO 14025, ISO 21930, ISO 14020 in ISO 14040.

Some countries in EU have already created national EPD data bases, that can be used to assess the environmental impact of the installed building materials for improvement of thermal characteristics of the envelope (i.e.: insulation + plaster or similar, window frames).

Where the data are not available the first approximation can be done with similar products from German database: oekobau.dat (available at www.nachhaltigesbauen.de)

You can also use the data from the following scheme:

**Table ???. Embodied energy for a selection of insulation materials (Source:*)**

| Material | Boundaries | Embodied energy (MJ/kg) | Embodied carbon (kg CO2/kg) |
|---|---|---|---|
| Cellulose | Cradle to Gate | 0.94 – 3.3 | - |
| Cork | Cradle to Gate | 4 | 0.19 |
| Fibreglass (glass wool) | Cradle to Site | 28 | 1.35 |
| Mineral wool | Cradle to Gate | 16.6 | 1.2 |
| Rockwool (stonewool) | Cradle to Site | 16.8 | 1.05 |
| Paperwool | Cradle to Grave | 20.2 | 0.63 |
| Expanded polystyrene (EPS) | Cradle to Gate | 88.6 | 2.5 |
| Polyurethane | Cradle to Gate | 72.1 | 3 |
| Woodwool (loose) | Cradle to Gate | 10.8 | - |
| Woodwool (board) | Cradle to Gate | 20 | 0.98 |
| Recycled wool | Cradle to Gate | 20.9 | - |

* Hammond, G and Jones, C (2008) Inventory of Carbon and Energy (ICE) Version 1.6a. (www.bath.ac.uk/mech-eng/sert/embodied/)

Table ??? shows the typical embodied energy (of manufacture) of a variety of insulation materials per kilogram of material and shows a range of values. Whilst this is useful information, it is important for contracting authorities to take into account not only the embodied energy, but also the end-use application of the materials, which takes the amount of material into account (thickness used and its density), the lifetime of the material and, most importantly, the thermal properties of the material for a given level of insulation. As such it is more useful to present the embodied energy in terms of the final application in the building taking these issues into account.

Source: http://ec.europa.eu/environment/gpp/pdf/thermal_insulation_GPP_%20background_report.pdf , Jun2 2010.

## 4.11. Share of Renewables in Overall Energy Consumption [Before] & [After]

**Nature**
Quantitative / Qualitative

**Metering Unit**
% of kWh of final energy /m2 / year

**Specifications & perimeter**
In the overall consumption of (delivered) energy for a whole year (from 4.1) the share of delivered renewable energy is estimated (biomass, % of RES in district heating, % RES in electricity used).

**Remarks from the WOs**
No remarks

# HANDBOOK
# INDICATORS FOR ENERGY AWARENESS ASSESSMENT ON COMMON MEASURING UNITS

**The indicators for social performance will be bulit during the AFTER process in order to identify what clues can help us to assess the reception and the impact of the energy saving measures by the tenants.**
**The first leads developped in the Handbook and implemented in the Inventory try to identify some aspects and some indicators used by the SHOs in order to follow the tenants' behavior.**

## 5.1. Complaints from tenants

**Nature**
Quantitative / Qualitative

**Metering Unit**
%

**Specifications & perimeter**
Average annual complaints above tenants of the perimeter compared to the total number of tenants.

**Remarks from the WP's**
No remarks

## 5.2. Vacancy rate [Before] & [After]

**Nature**
Quantitative / Qualitative

**Metering Unit**
% per year

**Specifications & perimeter**
The percentage of all flats which are unoccupied or not rented at a given time.

The indicator s broken down in 2 similar indicators for the following phases: the period before the implementation of the ESM and the period after the implementation of the ESM.

**Remarks from the WP's**
No remarks

# HANDBOOK
# INDICATORS FOR ENERGY AWARENESS ASSESSMENT ON COMMON MEASURING UNITS

## 5.3. Turnover rate

**Nature**
Quantitative / Qualitative

**Metering Unit**
% per year

**Specifications & perimeter**
The percentage per year of the total units in a social housing that change occupants.

**Remarks from the WPs**
No remarks

## 5.4. ESM awareness - concrete measures

**Nature**
Quantitative / Qualitative

**Metering Unit**
Describe the measure and give your opinion on the effect e.g.:
Recommendable – OK – No effect – Others (describe)

**Specifications & perimeter**
Concrete measures to encourage awareness. The concrete measures can be divided in
- Incentives (energy saving campaigns, climate campaigns, energy certificates)
- Breaking down barriers (economical subsidies, energy advisors (for the tenants), success stories)
- Operational (result contracts, energy manager)

**Remarks from the WP's**
No remarks

## 5.5. Costs of the ESM awareness measure

**Nature**
Quantitative / Qualitative

**Metering Unit**
euros

**Specifications & perimeter**
The costs must be specified with an approximate calculation such as printing costs, costs of it (e.g. creating a homepage for a campaign) and the number of hours spent x average gross salary.

**Remarks from the WP's**
No remarks

## 5.6. Satisfaction of the housing company regarding the ESM

**Nature**
Quantitative / Qualitative

**Specifications & perimeter**
Comment if you are satisfied or not with the ESM. Would you recommend it to your colleagues? What are the mistakes you did in the design/implementation of the ESM? What would you do differently if you could?

Comment in the reliability of the ESM – what are e.g. your experiences on prediction of failures?

**Remarks from the WP's**
No remarks

# HANDBOOK

## «TIPS» REGARDING THE IMPLEMENTATION OF THE ESM

**The indicators for economic performance should indicate the life cycle costs for an ESM within its perimeter.**
**AFTER mainly aims at identify the private cost efficiency of an ESM for a Social Housing Company.**

**Cost calculation differs from one country to another and from one SHO to another (interest rates, cost of energy, legal financing, etc...). The objective of the Inventory is mainly to manage to identify relevant indicators regarding the costs able to assess the efficiency of one measure.**

The tips regarding one ESM are supposed to highlight some direct recommandations thanks to the Social Housing Organizations' experiences and best practices.

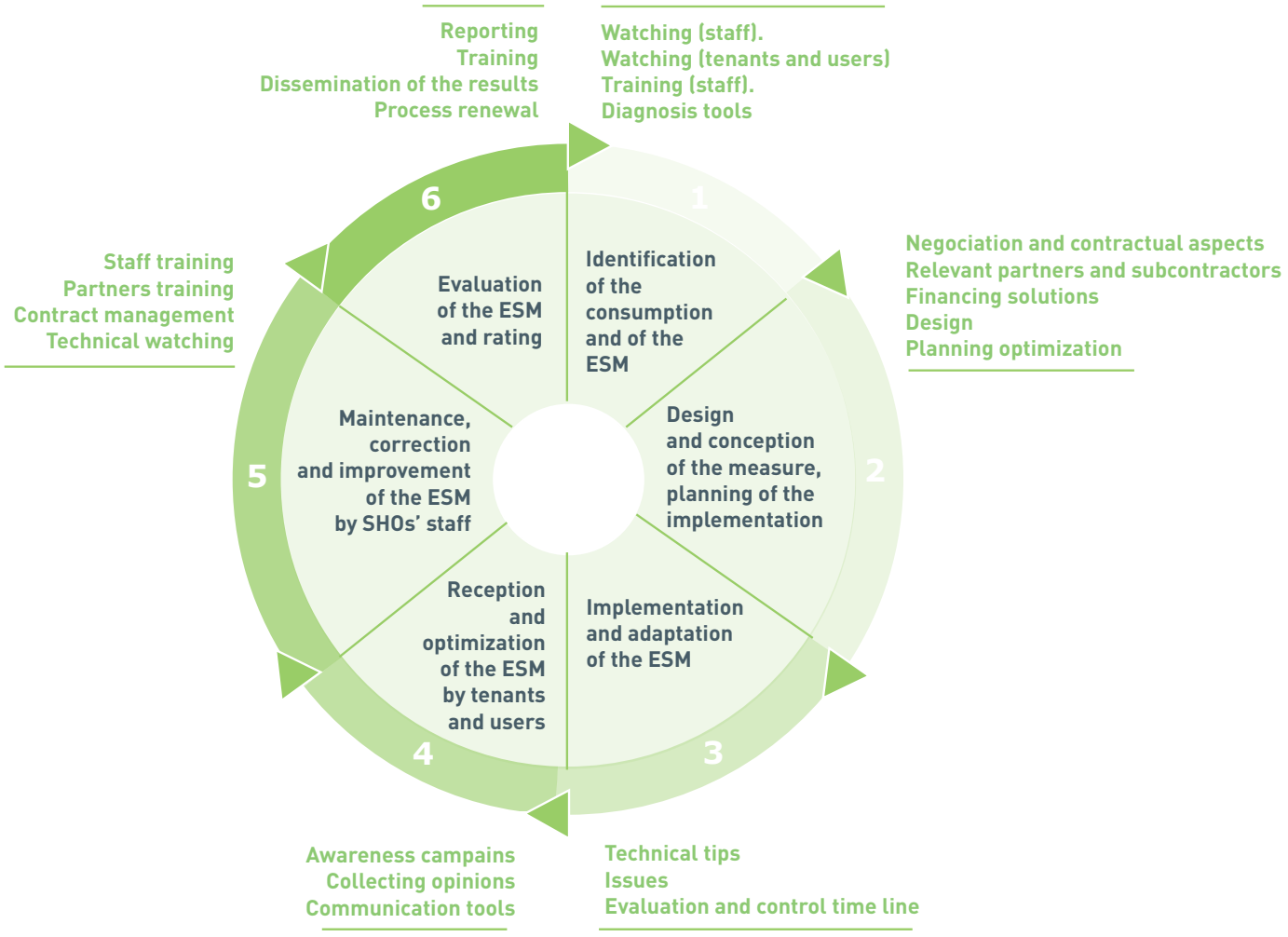
These tips will help to help to identify relevant practices in order to optimize the ESMs and some issues that may be related to these measures.
The objective is to highlight qualitative points to improve during the life cycle of the measure.
The solutions can be both technical maintenance points or operational and management innovations regarding a measure and can be implemented from the beginning of its implementation to the post-management of the ESM.

6 main steps can be identified in order to identify potential tips:

- **identification of the consumption and of the energy saving measures**: interventions and routines to implement in order to identify upstream the potential savings .
- **design and conception of the measure, planning of the implementation**: technical and operationnal definition of the measure adapted to the context of the company (frameworks, tools).
- **implementation and adaptation of the ESM**: on-field experience and issues identified.
- **reception and optimization of the ESM by tenants and users**: potential of optimization linked with tenants' education and awareness.
- **maintenance, correction and improvement of the ESM by SHOs' staff**: following of the routines after the implementation.
- **evaluation of the ESM and rating**: integration of the ESM in the SHOs asset management and standard tools.

# HANDBOOK

## «TIPS» REGARDING THE IMPLEMENTATION OF THE ESM



# HANDBOOK

# ANNEX A :
# DATA FOR LIFESPAN COSTS



## Annex A
(informative)
## Economical data for energy systems

Table A.1 presents some data about lifespan, annual maintenance costs and disposal cost for components and products. Column 3 displays a global value. National annexes can provide more detailed values of the costs for maintenance, repair and service.

Terms and definitions are in accordance with existing standards.

**Table A.1 - Data for lifespan and maintenance costs**

| Component | Lifespan Min – Max (years) | Annual preventive maintenance including operation, repair and servicing costs in % of the initial investment | Disposal cost in % of the initial investment |
|---|---|---|---|
| Air conditioning units | 15 | 4 | |
| Air coolers | 15 - 20 | 2 | |
| Air heaters, electric | 15 – 20 | 2 | |
| Air heaters, steam | 15 – 20 | 2 | |
| Air heaters, water | 15 – 20 | 2 - 4 | |
| Boiler - condensing | 20 | 1 - 2 | |
| Boiler – direct evacuation | 20 | 1 - 2 | |
| Boiler – Flue evacuation | 20 | 1 - 2 | |
| Burners, oil and gas | 10 | 4 – 6 | |
| Chimney | 15 – 20 | | |
| Condensers | 20 | 2 | |
| Control equipment | 15 –20 | 2 - 4 | |
| Control system - Central | 15-25 | 4 | |
| Control system – room control | 15 -25 | 4 | |
| Control valves, automatic | 15 | 6 | |
| Control valves, manual | 30 | 4 | |
| Convectors | 20 | 1 | |
| Cooling compressors | 15 | 4 | |

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## ANNEX A :
## DATA FOR LIFESPAN COSTS



Table A.1 - Data for lifespan and maintenance costs

| Component | Lifespan Min – Max (years) | Annual preventive maintenance including operation, repair and servicing costs in % of the initial investment | Disposal cost in % of the initial investment |
|---|---|---|---|
| Cooling panels and ceilings | 30 | 2 | |
| Dampers | 20 | 1 | |
| Dampers with control motors | 15 | 4 | |
| Diffusers | 20 | 4 | |
| Dual duct boxes | 15 | 4 | |
| Duct system for filtered air | 30 | 2 | |
| Duct system for non filtered air | 30 | 6 | |
| Electric board | 30 | 0,5 - 1 | |
| Electric heater – thermal storage heater | 20 – 25 | 1 | 1 |
| Electric heating – convector | 20 – 25 | 1 | |
| Electric floor heating | 25 –50* (*) if lifespan agreed according with tests results | 2 | 20 |
| Electric wiring | 25 - 50 | 0,5 - 1 | |
| Water floor heating | 50 | 2 | 20 |
| Evaporators | 15 - 20 | 2 | |
| Expansion vessels – membrane | 15 | 0,5 | |
| Expansion vessels with pad | 15 - 25 | 2 | |
| Expansion vessels, stainless | 30 | 1 | |
| Expansion vessels, steel | 15 | 2 | |
| Extract air grills | 20 | 10 | |
| Fan coil units | 15 | 4 | |

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## ANNEX A :

## DATA FOR LIFESPAN COSTS

EN 15459:2007 (E)

Table A.1 - Data for lifespan and maintenance costs

| Component | Lifespan Min – Max (years) | Annual preventive maintenance including operation, repair and servicing costs in % of the initial investment | Disposal cost in % of the initial investment |
|---|---|---|---|
| Fans | 15 - 20 | 4 | |
| Fans with variable flow | 15 | 6 | |
| Filter frames | 15 | 2 | |
| Filter material to be exchanged | 1 | 0 | |
| Filter material, to be cleaned | 10 | 10 | |
| Fire dampers, easy accessible | 15 | 8 | |
| Fire dampers, hidden | 15 | 15 | |
| Fuel tank | 30 | 0,5 | 5 – 10 |
| Gas tank | 30 | 0,5 | 5 |
| Grills in general | 30 | 4 | |
| Heat pumps | 15 - 20 | 2 - 4 | |
| Heat recovery units, cyclic | 15 | 4 | |
| Heat recovery units, static | 20 | 4 | |
| Humidifiers, steam | 4 - 10 | 4 | |
| Humidifiers, water | 10 | 6 | |
| Meters | 10 | 1 | |
| Valve | 10 | 1 | |
| Motors, diesel | 10 | 4 | |
| Motors, electric | 20 | 1 | |
| Pipes, Cu | 30 | 1 | |
| Pipes, composite or (look at Water floor heating) | 50 | 1 | |
| Pipes, stainless | 30 | 1 | |

# HANDBOOK

## ANNEX A :

## DATA FOR LIFESPAN COSTS



Table A.1 - Data for lifespan and maintenance costs

| Component | Lifespan Min – Max (years) | Annual preventive maintenance including operation, repair and servicing costs in % of the initial investment | Disposal cost in % of the initial investment |
|---|---|---|---|
| Pipes, steel in closed system | 30 | 1 | |
| Pipes, steel in open system | 15 | 1 | |
| Piping systems | 30 | 0,5 | |
| Pumps – circulation | 10 -20 | 2 | |
| Pumps - regulated | 10 - 15 | 1,(5 - 2 | |
| Radiators paint | 20 - 30 | 0 | |
| Radiators, water | 30 -40 | 1- 2 | |
| Shut off valves, automatic | 15 | 4 | |
| Shut off valves, manual | 30 | 2 | |
| Solar collector (Vacuum collector or plate collector | 15 - 25 | 0,5 | |
| Sound traps | 30 | 1 | |
| Tank storage for domestic hot water | 20 | 1 | |
| Tank storage with internal heat exchanger for domestic hot water | 20 | 1 | |
| Thermostats for radiators | 15 | 4 | |
| Valve with auxiliary power | 10 | 1 | 5 |
| Valve - Thermostatic | 20 | 1,5 | 5 |
| Variable flow units | 15 | 6 | |
| V-belt drive | 10 | 6 | |
| Wiring | 30 | 1 | |

# HANDBOOK

# ANNEX B : INFORMATION ON TYPES OF DIMENSIONS

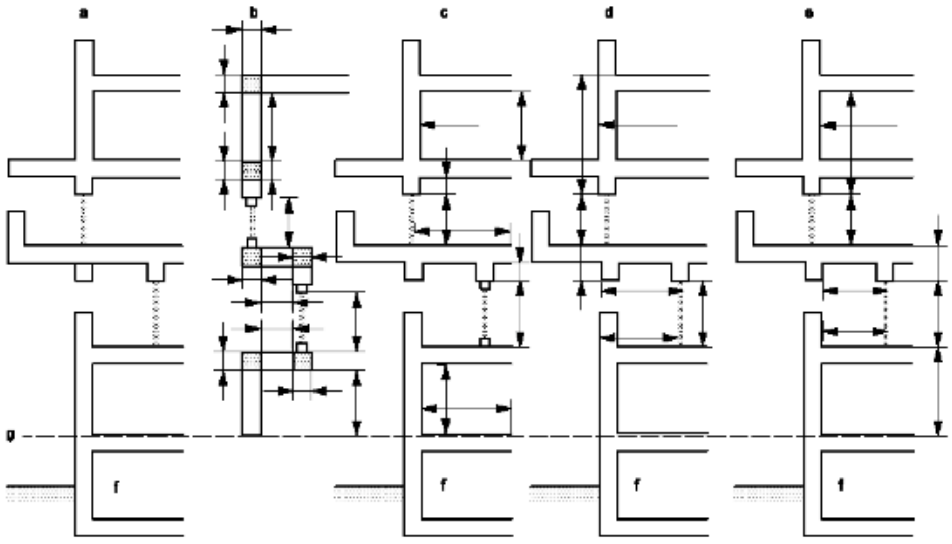


## Annex B
(informative)

## Information on type of dimensions

To apply the calculation method, the building envelope is divided into elements (see Clause 4 and Figure B.1). However, building-element dimensions are usually measured according to one of three systems: internal, overall internal, and external. These differ in the way that the flat areas of junctions between elements are included in the areas of these elements themselves.

Thus, for example, the term $\sum_i A_i U_i$ in Equation (2) is larger when using external dimensions than when using internal dimensions. Consequently, the values of $\Psi_k$ are generally smaller for external dimensions, and can even be negative in some cases such as external corners.




a Reality.
b Elements.
c Internal dimensions.
d External dimensions.
e Overall internal dimensions.
f Unheated.
g ISO 13370 applies to heat transfers below this boundary.

NOTE 1 For a heated basement, dimensions are measured to the basement floor slab.

NOTE 2 External dimensions can also be measured to the bottom of the floor slab.

**Figure B.1 — Examples of methods for determining building element dimensions**

# HANDBOOK

## ANNEX C :
## ENERGY CARRIERS

**Table 7 — Accounting energy carriers for measured energy rating**

| Row | R1 | R2 | R3 | R4 |
|---|---|---|---|---|
| | **Units** (l, kg, m3 ,kWh, MJ, etc.) | **Energy delivered** (Quantities) | **Gross calorific value** | **Energy delivered** (Energy content in kWh or MJ) |
| L1 | | Gas, Oil, Electricity District heating, Wood Energy carrier ($i$) | | |
| | **Units** (kWh, MJ, etc.) | **Energy exported** (Quantities) | | **Energy exported** (Energy content in kWh or MJ) |
| L2 | | Thermal: Electrical: | | |
| | **Units** (kWh, MJ, etc.) | **Renewable energy produced on site** | | |
| L3 | | Thermal: Electrical: | | |
| NOTE – The columns in Table 7 should be adapted to the building concerned. | | | | |

The annual delivered energy (row R2, line L1) corresponds to the total delivery of each energy carrier, as measured according to 7.3. The exported energy (row R2, line L2) is measured by an export meter or its surrogate. The delivered and exported amounts of energy carriers are indicated in the units as measured. The amount for each energy fuel is multiplied by its gross calorific value to obtain the energy content (row R4).

# HANDBOOK
# ANNEX D : PAYBACK PERIOD

**Net Present Value (NPV) and Internal Rate of Return (IRR)Calculator**

**(FILL-IN FIGURES IN BLUE)**
Change cash-flows and the Internal rate of Return! (in blue)

| | |
|---|---|
| Sumarized NPV | 1118 |
| Internal Rate of Return (IRR) | 5,56% |
| | |
| Interest rate (%) | 4 |
| Life expectancy (years) | 12 |
| Payback discounted (years) | 14 |

| Cash flow (euros) | Period (years) | Net Present Value (NPV) |
|---|---|---|
| -10000 | 0 | -10000 |
| 1000 | 1 | 962 |
| 1000 | 2 | 925 |
| 1000 | 3 | 889 |
| 1000 | 4 | 855 |
| 1000 | 5 | 822 |
| 1000 | 6 | 790 |
| 1000 | 7 | 760 |
| 1000 | 8 | 731 |
| 1000 | 9 | 703 |
| 1000 | 10 | 676 |
| 1000 | 11 | 650 |
| 1000 | 12 | 625 |
| 1000 | 13 | 601 |
| 1000 | 14 | 577 |
| 1000 | 15 | 555 |
| 0 | 16 | 0 |
| 0 | 17 | 0 |
| 0 | 18 | 0 |
| 0 | 19 | 0 |
| 0 | 20 | 0 |
| 0 | 21 | 0 |
| 0 | 22 | 0 |
| 0 | 23 | 0 |
| 0 | 24 | 0 |
| 0 | 25 | 0 |
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| 0 | 35 | 0 |
| 0 | 36 | 0 |
| 0 | 37 | 0 |
| 0 | 38 | 0 |
| 0 | 39 | 0 |
| 0 | 40 | 0 |
| 0 | 41 | 0 |
| 0 | 42 | 0 |
| 0 | 43 | 0 |
| 0 | 44 | 0 |
| 0 | 45 | 0 |
| 0 | 46 | 0 |
| 0 | 47 | 0 |
| 0 | 48 | 0 |

# HANDBOOK

## ANNEX E : AREAS



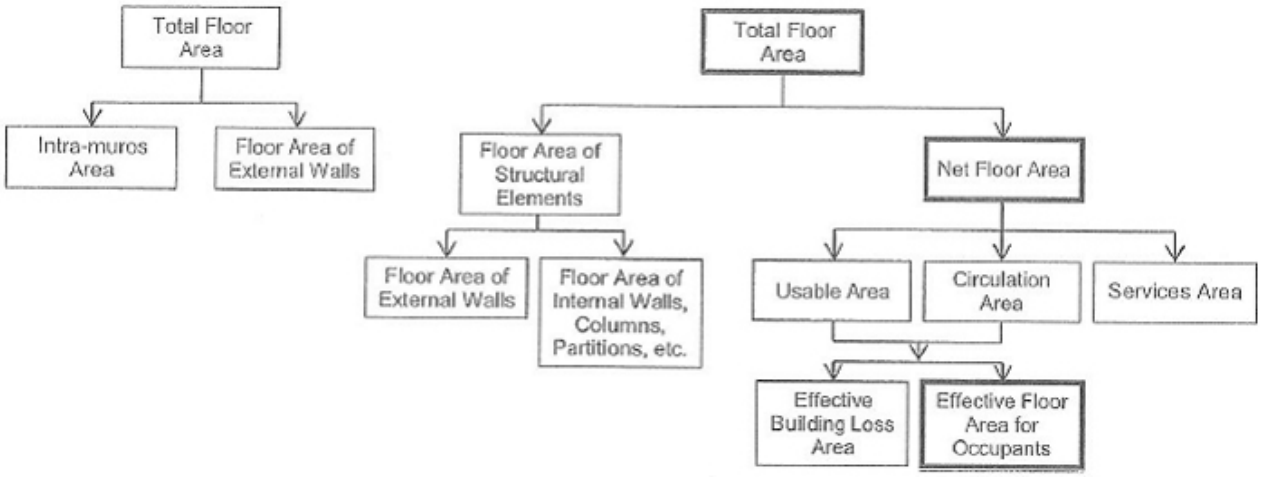



**Figure 2 — Components of total floor area**

# RETRO-COMMIS-SIONNING METHO-DOLOGY

# RETRO-COMMIS-SIONNING METHO-DOLOGY

# RCx CONTENT

# RCx
# INTRODUCTION TO AFTER RETRO-COMMISSIONING INVESTIGATION PLAN


**Retro-commissioning (RCx) is defined as the "systematic process for improving an existing building's performance by identifying and implementing relatively low-cost operational and maintenance improvements, helping to ensure that the building's performance meets owner expectations ".**

California Commissioning guide : Existing buildings. California Commisssioning Collaborative, 2006

The AFTER "Retro-commissioning Investigation Plan" is a tool assessing the actual efficiency of Pilot Sites in order to identify optimization leads for AFTER Pilot Energy Saving Measures (ESMs) - cf. Appendix A page 35 for the definition.
ESMs are the raw material of the AFTER Project. The Inventory has been a first step to identify them and to foresee the optimization process for these energy measures.

The objective of the Retro-commissioning (RCx - cf. Appendix A and Appendix B page 36) process is to test optimization solutions for these specified ESMs in order to improve the energy performance of the housing stock of the participating SHOs.

The RCx document presents a complete and practical step-by-step introduction on how to perform the RCx investigation (cf. Appendix C page  to have an overview of the global process). The investigation will allow SHOs to give a description of the existing Pilot building and to identify the equipment and system that will benefit for the optimized version of the ESM.

As a consequence, the RCx aims at providing the necessary practical information and data that are needed to identify clearly the building's performance and its potential to be improved.

Next step will be described in The Common Protocol for Evaluation. Once the optimization leads have been identified, this protocol will allow us to follow the implementation of the ESM including the optimization solutions, to control/monitor its outputs on a regular and common basis process.

The Appendix part of this document will provide a more exhaustive introduction to the "AFTER" RCx methodology and some general elements about the RCx definition and state of the art.

# RCx
# WHAT IS RETRO-COMMISSIONING?

## What is retro commissioning?

Retro-commissioning (RCx) is defined as the "systematic process for improving an existing building's performance by identifying and implementing relatively low-cost operational and maintenance improvements, helping to ensure that the building's performance meets owner expectations ". Retro-commissioning is intended to be an equivalent of Commissioning for existing buildings as its main objective is to understand "how building equipment and systems function in order to enhance a building overall performance ".
As footnotes indicate it, Retro-commissioning methodologies have been particularly developed within the American procedures to improve the energy performance in the buildings and especially regarding facilities. Thereof, the main existing retro-commissioning literature focuses on office and production rooms / buildings.

This particular background implies 3 remarks regarding the potential application for the AFTER Project:

1.If retro-commissioning is an interesting idea in order to implement a standardized method to improve the energy efficiency of buildings, the process has to be adapted for residential buildings, and especially for social housing.

2.In the RCx process in "real life", you start by finding the right buildings for retro-commissioning and then you find the ESMs relevant to carry our the retro-commissioning. In AFTER we define the ESMs, we want to assess, and then we find the buildings to test them.

3. Existing retro-commissioning methodologies have been created in a Northern American context for heating and cooling devices based on energy devices and using electricity as energy carrier. European heating systems, and systems included in the AFTER Project, are more prominently based on water warmed by different energy carriers.

As a consequence, AFTER partners will have to be watchful on conserving the essential objectives of the Retro-commissioning (improving the energy performance) At the same time the procedure should be kept as simple as possible focusing as a starting point on objectives and adjustments according to the SHOs needs.

### when to do it ?

- an unjustified, high energy-use index

- persistent failure of equipment and/or control system (worn out, old equipment should be replaced before the commission begins)

- tenants complaints

- indoor air quality problems

# RCx
# WHAT IS RETRO-COMMISSIONING?

## AFTER Retro Commissioning Methodologies: Background

Retro-commissioning has been hugely debated during the AFTER process.
As a matter of fact, the concept as presented in the American literature can be understood in 2 ways, both:

- as a global process, for improving a buildings performance using Energy Serving Measures (investigation/implementation/post-implementation)
- as a tool, the procedure document that will give the necessary framework to identify the deficiencies of an existing building and to propose potential optimization and improvements.

Thereof, we have to specify –as an introduction for this RCx methodology- what are the main objectives intended for RCx process in the AFTER project. This reminder has to be done step-by-step regarding the original definition of the RCx (a "systematic process for improving an existing building's performance by identifying and implementing relatively low-cost operational and maintenance improvements, helping to ensure that the building's performance meets owner expectations") but trying to fit as close as possible to the SHOs' realities.

**1.1. «A systematic process for improving an existing building's performance...»**
The philosophy of RCx corresponds to a systematic process of improvement regarding the performance of a building. This wording implies several consequences, particularly for "AFTER":

- A "systematic process" intends to create a methodology and a procedure that will be the same for the different pilot sites included in the AFTER Project.
- The idea of "improving an existing building's performance" has to be weighted by the delays of the AFTER Project. As a consequence, the RCx will be very directed to the equipment and systems of a building that could enhance its global performance.
- RCx should not be restricted to the pilote sites but be applicable for all other ESMs of the same kind –be it he AFTERSHOs be it other (social) housing companies

Regarding the special features of the Social Housing Companies, the AFTER RCx process should be very pragmatic and inspired by existing routines implemented by companies to optimize their energy consumptions.
As a consequence the RCx is closely linked to the experience and knowledge of a Social Housing Company regarding its housing stock and its prominent issues in order to go straight to the point.

**1.2. «... By identifying and implementing low-cost operational and maintenance improvements...»**
The RCx links diagnosis ("identifying") and proposals ("implementing") regarding the improvement a building performance. As explained in the definition, RCx focus mainly on "low-cost" (that intend we must give priority to some low key intervention with small investment) operational and maintenance improvements".

**1.3. «... Helping to ensure that the building's performance meets owner expectations.»**
This last part of the definition has to be revised especially regarding the AFTER project and its topics.

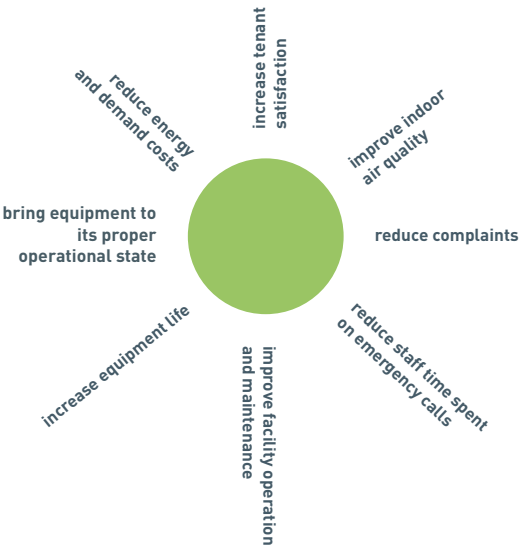
As we focus on housing and most particularly on social housing, the concept of "owner expectations" has

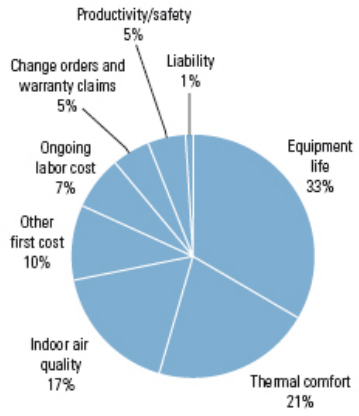
# RCx
# WHAT IS RETRO-COMMISSIONING?

to be widened and has to integrate the tenants. As a consequence, to "ensure the building's performance meets owner expectations" must cover up a diversity of objectives that are gathering economic performance objectives, energy performance objectives and social performance objectives.

Among these objectives we must list:
- To ensure that equipment and systems are reaching their proper operational state and their expected performance (economic/energy performance)
- To reduce energy costs (economic/social performance)
- To identify and monitor tenants complaints as an additional means of identifying deficits and
- To reduce tenants complaints and to increase satisfaction (social performance)
- To improve operation and maintenance routines and reduce staff time on emergency calls (economic performance) .

## RCx impacts




datas from
Lawrence Berkeley National Laboratory,
Portland Energy Conservation Inc
and Energy Systems Laboratory, Texas A&M University

# RCx
# WHAT IS RETRO-COMMISSIONING?

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# RCx
# MAIN STEPS OF THE RCx PROCESS.

## 1. Select project
The selection of the concerned project is a very particularly step in the AFTER Project and has been performed within the frame of WP8.

Else - in a normal RCx process - the selection of the building is a very important first step.
As the Oregon Office of Energy (see foot note in ANNEX A) indicates in its Retro-commissioning Handbook, "Some buildings make better candidates for retro-commissioning than others (...) the most broken buildings may not be attractive".

## 2. Develop a team
The retro-commissioning process supposes a good organization within the Social Housing Organization. During its investigation phase, SHOs will have to name a team sharing the different responsibilities. This team should identify the different persons responsible for the different stages of the Retro-commissioning plan (global management, collecting data, technical staff involved, and contacts with tenants). The interfaces between the different elements of the team and the managing staff of the Social Housing Company should be indicated. Partnerships have also to be mentioned.

## 3. Gather documentation and information
In order to know exactly how the building is working regarding the first collected testimonies, the participating SHO should collect the documents necessary to know what are the different equipment and systems involved and what is their expected performance. And energy bills.

This step has to be very efficient and to focus on the most relevant documents for the project.

## 4. Review building documentation
A first overview on the building documentation should help to individualize some of the main deficiencies of the building or potential missing points regarding the energy performance of the building.

## 5. Description of building equipments
The description of the building equipment is a follow up on the first overview with more detailed information on systems as well as equipment. It includes the heating system, the Domestic Hot Water (DHW) system, the ventilation and the lighting.

## 6. Perform a first direct site assessment
A first overview on the building documentation should help to individualize some of the main deficiencies of the building or potential missing points regarding the energy performance of the building.

The goal of the site assessment is to obtain an in-depth and on field understanding on how the building are currently operated and maintained and to identify how these O&M could be improved. The main role of this first assessment is to create a visual contact of the building and a visual assessment of its performance. It also represents an opportunity to get some complementary information asking questions to the closest operators of the building: the technical staff of the SHO and tenants. This is a very simple and low cost means of monitoring.

This first direct assessment could be scheduled as a walkthrough with the building's caretaker or some technical member of the SHO and some tenants of the building. During the walkthrough a listing is done highlighting major deficiencies.

# RCx
# MAIN STEPS OF THE RCx PROCESS.

## 7. Consumption
The consumption i registering the data for the energy use of the building - if possible for the last five years. It also includes registering the costs of energy from the energy bills - also from the last five years of possible.

For the use of electricity it is also important to describe, which different elements are included in the consumption - e.g. heating, ventilation, out door lighting, caretakers apartment etc.

## 8. Metering
Describe the meters in the building and the frequency of readings and how they are performed. Also describe the sub metering, if any.

## 9. Operation & maintenance actions
The overview is to be completed according to O&M contracts. It includes periodic preventive actions and corrective actions.

## 10. Master list of deficiencies
According to the review of the building documentation and the first direct site assessment, the retro-commissioning team will produce a first Master List summarizing the different deficiencies observed during the first phase of the process. The list will present a global identity kit of the name of the system, equipment or tool impacted by the deficiency, a description of the observed issue and a suggestion of optimization in order to improve the expected of the system, equipment or tool in order to reach at least its expected performance.

## 11. Diagnostic monitoring and test plans
Regarding the Master list of deficiencies, the retro-commissioning team may identify what complementary data and test would be necessary in order to obtain a better knowledge of the equipment/ system/tool performance.
The diagnostic monitoring and test plan should complete the first visual observation accomplished during the walkthrough. The diagnostic monitoring will allow the team to observe, if needed, the evolution of the concerned system/equipment or tool under typical conditions and different scenario. This experiment will permit to identify when the system is correctly or most efficiently operating.
The Oregon Office of Energy lists 2 main diagnostic methods and test plans that will complete the first Master list of Deficiencies:

- Data logging
- Manual functional testing

The tools used during the retro-commissioning will also be used during the evaluation of the testing of the optimized ESM on sites and will be part of the "Common Evaluation Protocol".

## 12. Recommendations and ESMs optimization
Once the Master List of deficiencies has been completed, the SHO and the corresponding WP leader will identify the most relevant improvement to be tested regarding to cost-effectiveness factors, expected energy efficiency factors or social performance factors. After optimization, these ESMs will be tested during the evaluation phase. Their performance regarding the baseline period inventoried during the retro-commissioning will be analyzed and documented using the "Common Evaluation for Testing Live on Sites of the Pilot ESM".

# TOOL

Please complete the follow tables step-by-step with all the requested information regarding your Pilot Building and your Pilot ESM.

The AFTER Handbook (D2.3) will help you to identify the calculation criteria, if needed, to complete all the lines of these tables.
A more complete description of the RCx step-by-step process can be found in Appendix B page 34 of this document.

# RCx
# AFTER RCx - STEP BY STEP

## 2.1. STEP 1: SELECT PROJECT AND BUILDING

### 2.1.1. Identify your Pilot Building

(Complete the cells with relevant collected data on your Pilot building - cf. AFTER Inventory)

| | |
|---|---|
| **Name of the Social Housing Organization owner of the building** | |
| **Country** | |
| **Address of the building** | |
| **Year of construction of the building (beginning/end)** | |
| **Number of dwellings** | |
| **Number of inhabitants** | |
| **Living surface (m²). Number of stories** | |
| **What kind of heating (energy carrier)?** | |
| **Pilot ESM reported in the AFTER Inventory related to the building** | |

### 3.1.2. What facts did orientate you toward this building?

(According to your experience and knowledge of your housing stock, check one or several possibilities. Add details if possible.)

- ☐ Regular complaints by tenants (WP3)
- ☐ Testing building to be optimized for dissemination (WP3)
- ☐ Persistent failure of equipment or control system identified by technical staff (WP4)
- ☐ An unjustified and high-energy index regarding its expected performance (WP5 and WP6)
  Equipment or system identified:
  .....
  .....
- ☐ Other short-term O&M reasons to implement commissioning activities in order to enhance the existing performance of the building - e.g.:

  - High demand of energy for heating
  - High demand of electricity for heating
  - High demand of DHW
- ☐ Other things
  .....
  .....

**Regarding these facts, fix general objectives**

Write down the facts - and reflect on how to manage the problems in the building - to set the goals and fix the general objectives of the RCx process. What can be achieved? What would you like to achieve?

### 2.1.3. Photos of the Pilot Building

(Add photos of the building and equipments concerned by the ESM).

# RCx
# AFTER RCx - STEP BY STEP

## 2.2. STEP 2: DEVELOP A TEAM

Identify the staff that will lead or participate to the RCx process. Describe the tasks of every patner.

| | Role and involvement | Persons (name, function, company) | Contact (tel, email) |
|---|---|---|---|
| **3.2.1. RCx responsible** | | | |
| **3.2.2. Social Housing Company contact** | | | |
| **3.2.3. Internal technical Staff** | | | |
| **3.2.4. Facility manager** | | | |
| **3.2.5. Caretaker of the building** | | | |
| **3.2.6. Tenants representatives (if relevant)** | | | |

## 2.3. STEP 3: GATHER DOCUMENTATION

| | Person to contact to obtain the documents | Targeted information in the documentation to gather | List of documents | Essential / optional (check or precise WP) | | Obtained | |
|---|---|---|---|---|---|---|---|
| | | | | Ess. | Opt. | Yes | No |
| **a. Energy data** | | | | | | | |
| Energy Performance Certificate | | | | | | | |
| Energy bills | | Real consumption and costs for a whole year (since 2007 if possible), for electricity, gas,... all type of energy + water | | | | | |
| **b. General information on the management of the building** | | | | | | | |
| Contracts on operation and maintenance | | Costs, kind of actions included in the contracts, frequency of interventions... | | | | | |
| Contracts with caretakers | | Mission, costs, seniority in the position | | | | | |
| Tenants organization | | Existence, missions, involvement, organization, relationship between tenants and SHO | | | | | |
| Energy strategic plan for the building | | List of future energy saving measures already planned for the next 5 years | | | | | |
| **c. Building characteristics** | | | | | | | |
| Architect's plans, BIM | | | | | | | |

# AFTER RCx - STEP BY STEP

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Photographs | | | | | | | |
| Energy audit, diagnosis | | If existing | | | | | |
| **d. Building equipment** | | | | | | | |
| List of equipments with description and technical caracteritics | | If existing | | | | | |
| Manufacturer documentation for all or most equipment | | | | | | | |
| O&M manuals for all or most equipment | | | | | | | |
| Book of O&M interventions | | Historic of operation and maintenance actions (listing, book...), check of respect of contracts | | | | | |
| Critical reviews of specific periodic inspections | | | | | | | |
| Functional diagrams of the systems | | Diagrams of the systems (ex: boilers and distribution network diagrams) | | | | | |
| **e. Documentation from/for the tenants** | | | | | | | |
| Handbooks for tenants for all or most equipment | | | | | | | |
| Results of survey of tenants | | If existing | | | | | |
| List of tenants complaints | | | | | | | |

# 2.4. STEP 4: BUILDING DESCRIPTION

## 2.4.1. Provide a detailed building description using the Handbook if needed.

| | |
|---|---|
| **Total living surface (m²)** | |
| **Total heated surface (m²)** | |
| **Number and size of dwellings**<br>(by surface or number of rooms) | Ex:<br>10 dwellings of 3 rooms / of 75 m²<br>8 dwellings of 4 rooms / of 90 m²<br>... |
| **Type of windows** | |
| **Type of walls / constructive type** | |
| **Type of roof, terraces** | |
| **Ceillar, basement** | |

## 2.4.2. Identify the previous refurbishments implemented on the building

| **Year of implementation** | **Type of action(s):**<br>Windows / wall insulation / roof insulation / ... | **Refurbishment description** |
|---|---|---|
| | | |
| | | |
| | | |

# 2.5. STEP 5: DESCRIPTION BUILDING EQUIPMENTS

## 2.5.1. Heating system equipments concerned by the ESM

| | Energy(ies) | Type of system(s) | Type of emission |
|---|---|---|---|
| | ☐ Electricity<br>☐ Gas<br>☐ Heating Oil<br>☐ Wood<br>☐ District heating<br>☐ Solar<br>☐ Other:_____ | ☐ Heat pump<br>☐ Electric convectors<br>☐ Boiler<br>☐ Wood stove<br>☐ Other:_____ | ☐ Radiators<br>☐ Convectors<br>☐ Fan coils<br>☐ Heating floor<br>☐ Other:_____<br>☐ with thermostatic valves |
| **Distribution** | ☐ Individual systems<br>☐ Collective systems | | |
| | Number of heating networks starting from the generation:_____ | | |
| **Controls** | ☐ Presence of scheduler (if individual systems)<br>☐ Outside temperature compensated control<br>☐ Different control for each network (ex: north and south facades | | |
| **Description** | | | |

| **Heating Equipment #1** | |
|---|---|
| **Name, brand** | |
| **Energy** | |
| **Type** | |
| **Start-up date** | |
| **Number (if identical)** | |
| **Power (kW)** | |

| Heating Equipment #2 | |
|---|---|
| **Name, brand** | |
| **Energy** | |
| **Type** | |
| **Start-up date** | |
| **Number (if identical)** | |
| **Power (kW)** | |

## 2.5.2. Domestic Hot Water (DHW) system equipments concerned by the ESM

| | **Energy(ies)** | **Type of system(s)** | |
|---|---|---|---|
| | ☐ Electricity<br>☐ Gas<br>☐ Heating Oil<br>☐ Wood<br>☐ District heating<br>☐ Solar<br>☐ Other:_____ | ☐ Heat pump<br>☐ Electric convectors<br>☐ Boiler<br>☐ Wood stove<br>☐ Other:_____<br>☐ Same as heating system | |
| | ☐ Individual systems<br>☐ Collective systems | | |
| **Description** | | | |

| DHW Equipment #1 | |
|---|---|
| **Name, brand** | |
| **Energy** | |
| **Type** | |
| **Start-up date** | |
| **Number (if identical)** | |
| **Power (kW)** | |
| **Tank volume (in Liter)** | |
| **Tank operating temperature (in C°)** | |

## 2.5.3. Ventilation system equipments concerned by the ESM

| | **Energy(ies)** | **Type of system(s)** | |
|---|---|---|---|
| **Distribution** | ☐ Natural ventilation<br>☐ Hybrid ventilation<br>☐ Controlled Mechanical Ventilation System | ☐ Classic CMV (extraction)<br>☐ Hygro CMV<br>☐ Double flow CMV (with Heat recovery) | |
| **Description:**<br>(Its very important to know if is ventilation system local or centralized) | | | |

# RCx
# AFTER RCx - STEP BY STEP

| Ventilation Equipment #1 | |
|---|---|
| Name, brand | |
| Energy | |
| Type | |
| Start-up date | |
| Number (if identical) | |
| Power (kW) | |
| Nominal flow (m3/h) | |

| Ventilation Equipment #2 | |
|---|---|
| Name, brand | |
| Energy | |
| Type | |
| Start-up date | |
| Number (if identical) | |
| Power (kW) | |
| Nominal flow (m3/h) | |

## 2.6. STEP 6. PERFORM A FIRST DIRECT SITE ASSESSMENT

### 2.6.1. Walk-through

| **Building enveloppe** | **Status** |
|---|---|
| Roof and attic | |
| Walls | |
| Windows, doors and skylights | |
| Cellar | |
| **Building equipment** | |
| Heating System<br>Distribution System | |
| Automatic | |
| Hot domestic water system | |
| Ventilation system | |
| Lighting in common areas<br>Other electrical installations | |
| **Management** | |
| Review building operation schedules | |
| Review tenants information and awareness | |

## 2.6.2. Dwelling visit

| | |
|---|---|
| **a. Information to gather** | |
| Identification of individual technical equipements concerned by the ESM | |
| Rent (EUR/month), energy and service charges linked to the equipment concerned by the ESM | |
| Individual energy consumption | |
| Visual inspection of quality and proper functioning | |
| o Equipments | |
| o Moisture detection | |
| o Inspection of air vents: obstruction of inlets? Of outlets? Cleaned filters? | |

| | |
|---|---|
| **b. Other potential types of measurements** | |
| Temperature | |
| Humidity | |
| CO2 | |
| IR thermography | |
| Ventilation air flow rates | |
| Illumination measures | |

# RCx
# AFTER RCx - STEP BY STEP

## 2.7. STEP 7: CONSUMPTION

### 2.7.1. Energy Consumption for the building (raw data)

| Year | | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| **Electricity** | in kWh (final energy) | | | | | |
| **Natural Gas** | in kWh (higher calorific value) | | | | | |
| **District Heating** | in kWh | | | | | |
| **Wood** | in m3 | | | | | |
| **Home heating oil** | in... | | | | | |
| **Other:_____** | in... | | | | | |
| **Water** | in m3 | | | | | |

### 2.7.2. Energy bills for the building (costs in EUR)

| Year | | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| **Electricity** | Standing charge Power = _____ kW | | | | | |
| | Consumption | | | | | |
| **Natural Gas** | Standing Charge | | | | | |
| | Consumption | | | | | |
| **District Heating** | Standing Charge | | | | | |
| | Consumption | | | | | |
| **Wood** | Standing Charge | | | | | |
| | Consumption | | | | | |
| **Home heating oil** | Standing Charge | | | | | |
| | Consumption | | | | | |
| **Other:_____** | Standing Charge | | | | | |
| | Consumption | | | | | |
| **Water** | Standing Charge | | | | | |
| | Consumption | | | | | |

# 2.8. STEP 8: METERING OF THE ESM

## 2.8.1. Overall Meters

| Energy | Presence | Frequence of meter reading | Type of reading | Remarks |
|---|---|---|---|---|
| **Electricity** | ☐ Yes<br>☐ No | | ☐ Manual<br>☐ Automatic (AMR)<br>☐ Only with bills (by the supplier) | |
| **Natural Gas** | ☐ Yes<br>☐ No | | ☐ Manual<br>☐ Automatic (AMR)<br>☐ Only with bills (by the supplier) | |
| **District Heating** | ☐ Yes<br>☐ No | | ☐ Manual<br>☐ Automatic (AMR)<br>☐ Only with bills (by the supplier) | |
| **Wood** | ☐ Yes<br>☐ No | | ☐ Manual<br>☐ Automatic (AMR)<br>☐ Only with bills (by the supplier) | |
| **Home heating oil** | ☐ Yes<br>☐ No | | ☐ Manual<br>☐ Automatic (AMR)<br>☐ Only with bills (by the supplier) | |
| **Other:_____** | ☐ Yes<br>☐ No | | ☐ Manual<br>☐ Automatic (AMR)<br>☐ Only with bills (by the supplier) | |
| **Water** | ☐ Yes<br>☐ No | | ☐ Manual<br>☐ Automatic (AMR)<br>☐ Only with bills (by the supplier) | |

# RCx
# AFTER RCx - STEP BY STEP

## 2.8.2. Sources of energy consumption

**What are the sources of consumption included in the electricity bill?**

- ☐ Ventilation systems
- ☐ Lighting in common parts
- ☐ Outside lighting
- ☐ Underground car park (lighting, ventilation, automatic gate)
- ☐ Lifts
- ☐ Caretaker lodge
- ☐ Electrical equipments in boiler room (pumps, etc.)
- ☐ Security, access services, datalogger, TBM, etc.
- ☐ Common Electrical domestic appliances
- ☐ ----------
- ☐ ----------
- ☐ ----------
- ☐ ----------

## 2.8.3. Submetering

| | | |
|---|---|---|
| Is there a submetering by apartment (for example heat cost allocators)? | ☐ Yes | ☐ No |
| Is there a submetering between heating and DHW consumption? | ☐ Yes | ☐ No |
| Is there a submetering for electricity consumption? | ☐ Yes | ☐ No |

# RCx
# AFTER RCx - STEP BY STEP

**Complete the table depending on the existing submeters:**

| in kWh (raw data) | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|
| Heating | | | | | |
| DHW | | | | | |
| ... | | | | | |
| ... | | | | | |
| ... | | | | | |
| ... | | | | | |
| ... | | | | | |
| ... | | | | | |

# 2.9. STEP 9: OPERATION AND MAINTENANCE ACTIONS

**To complete according to the O&M contracts:**

## 2.9.1. Identify the periodic preventive actions taken in the building

| Description | Last interventions | Included in the contract? | Cost |
|---|---|---|---|
| **a. Heating System** | | | **Total cost: _____ EUR/year** |
| Ex: Boiler inspection | | ☐ Yes ☐ No | |
| Ex: Change of too old burner, circulation pump | | ☐ Yes ☐ No | |
| Ex: Pipe cleaning | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| **b. DHW System** | | | **Total cost: _____ EUR/year** |
| | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| **c. Ventilation System** | | | **Total cost: _____ EUR/year** |
| Ex: Change of filters | | ☐ Yes ☐ No | |
| Ex: Filters cleaning | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |

## 2.9.2. Identify the corrective actions taken in the building

| Description | Last interventions | Included in the contract? | Cost |
|---|---|---|---|
| **a. Heating System** | | | **Total cost: _____ EUR/year** |
| Ex: Breakdown, dysfunctioning, inponerable events | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| **b. DHW System** | | | **Total cost: _____ EUR/year** |
| | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| **c. Ventilation System** | | | **Total cost: _____ EUR/year** |
| | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |
| | | ☐ Yes ☐ No | |

# 2.10. STEP 10: MASTER LIST OF DEFICIENCIES AND COMPAINTS

**List of encountered technical failures or complaints: review of actions during the five last years related to deficiencies and list of complaints (tenants, caretakers ...)**

## 2.10.1. List of deficiencies

| Item # | WP # | Equipment or part of the system concerned by the deficiency | Description of the deficiency | Recommanded improvement | Type of intervention | Status |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## 2.10.1. Registering of complaints

| Date | Source of the complaint | Description of the complaint | Number of similar complaints in the building | Type of complaint | Estimated relevancy of the complaint | Corrective action |
|---|---|---|---|---|---|---|
| | Tenant<br>Caretakers<br>SHO | | | - thermal comfort<br>- moistures development (mould development)<br>- acoustic troubles (neighbours, traffic, noice from heating, ventilation, pipes)<br>- difficulty to use systems,<br>.... | | ☐ Yes ☐ No<br>Description |
| | | | | | | |

# 2.11. STEP 11: DIAGNOSTIC MONITORING AND TEST PLANS

## 2.11.1. Need for more diagnostic monitoring and testing?

- ☐ Yes
- ☐ No

## 2.11.2. What element need more monitoring and why?

| Item # | WP # | Equipment or Part of the System needing more diagnostic monitoring | Reason |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

## 2.11.3. What type of diagnostic monitoring is chosen?

- ☐ Datalogger plan
- ☐ Functional test performance
- ☐ Manual reading of meters
- ☐ Visual inspections
- ☐ Others

**Datalogger plan**

| | |
|---|---|
| **Brand name of the datalogger** | |
| **Start Date and Time** | |
| **Stop Date and Time** | |
| **Duration** | |
| **Sampling frequency** | |
| **Total loggers** | |
| **Total points** | |
| **Total loggers** | |

# RCx
# AFTER RCx - STEP BY STEP

| Equipment name | Point name | Measurement | Type<br>Module | Units | Min. | Max. |
|---|---|---|---|---|---|---|
| | | | | | | |

## 2.11.4. Functional Test Performance

| Equipment name | | | |
|---|---|---|---|
| Checklist items | | Description | Comment |
| #1 | | | |
| #2 | | | |
| #3 | | | |

## 2.12. STEP 12: RECOMMANDATIONS FOR ESMs' OPTIMIZATION

**Regarding the deficiencies identified during the former steps of the RCx process, develop some proposals on optimization tips and solution for the tested ESM.**

| Item # | WP # | Deficiency identified | **Optimization potential for the ESM**<br><br>( Choices:<br>- improve the economic model of the ESM.<br>- enhance the energy efficiency.<br>- increase the social performance and the reception of the ESM by tenants.) | **Type of optimization proposed for the ESM**<br><br>( Choices:<br>- management & strategic decision<br>- technical intervention (control, maintenance replacement)<br>- increase the social performance and the reception of the ESM by tenants.) | **Description of the optimization proposal/ solution** |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

# COMMON EVALUATION PROTOCOL

# COMMON EVALUATION PROTOCOL

# PROTOCOL
## CONTENT

# PROTOCOL
## INTRODUCTION


**The AFTER Handbook is the starting point of the AFTER global methodology .**
**This Handbook will be used in the Inventory phase in order to deliver an ID for the different ESMs collected by the partners and to present some of the specificities regarding ther implementation.**

**The Handbook will be then completed regarding the characteristics of the 18 Pilot ESMs. These characteristics will be linked with the identification of the ESMs and of the indicators aiming at precising their criteria of efficiency.**

### 0.0. INTRODUCTION

The International Performance Measurement and Verification Protocol (IPMVP) provides standardized methods and tools to assess the results of energy saving investments and measures.
In order to ensure the comparability of the pilot sites outcomes, AFTER Project partners will have to use a same framework to evaluate the impact of the ESMs tested «live» on pilot sites.
A simplified version of the IPMVP will be used in order to build a common methodology.

This «Common Evaluation Protocol» follows the general structure of the IPMVP, simplifying some of its aspects.
AFTER Project collects different types of ESMs. As a consequence, the common protocol is a very simple version which will be customized with the inputs of every WPs.
Its main objective is to illustrate a process of assessment that will adapted regarding specificities of every type of intervention on the housing stock.

### 1. IPMVP : BACKGROUND.

IPMVP has been launched in 1995 by the US Department of Energy («North American Energy Measurement and Verification Protocol»). Its aim was to provide a general tool to quantify and assess energy savings created by ESCOs

The use of this document has spread to national and government agencies in the U.S before becoming an international tool used in several countries and translated in 10 different languages.

# PROTOCOL
## INTRODUCTION

The original protocol has been regularly updated. Since 2002, IPMVP has been transformed into an independant non-profit corporation to encourage an international dissemination. Private corporation Efficiency Valuation Organization (EVOs) manages today the registered trademark IPMVP© (www.evo-world.com). Its website provides a complete library of documents gathering different translated volumes of the Protocol.

## 2. IPMVP : CONTENT.

IPMVP has to be considered as a guidance document. Its different volumes presents «Concepts and Options for Determining Energy and Water Savings» (vol.1) «Concepts and Options for Improved Indoor Environmental Quality (vol. 2)).

IPMVP gives a methodological framework that has to be adapted into concrete Measurement and Verification Plans by users.
The IPMVP presents three major elemnts that will led users in their assessment process :

- a global approach to calculate energy savings integrating «adjustement» to ponderate the obtained results before and after the Energy Saving Measures.
- four options to describe methods for estimating the energy savings.
- a model for a Measurement and Verification Plans divided into a several steps.

### 2.1. IPMPVP GLOBAL APPROACH

Energy savings are determined according to a global equation :

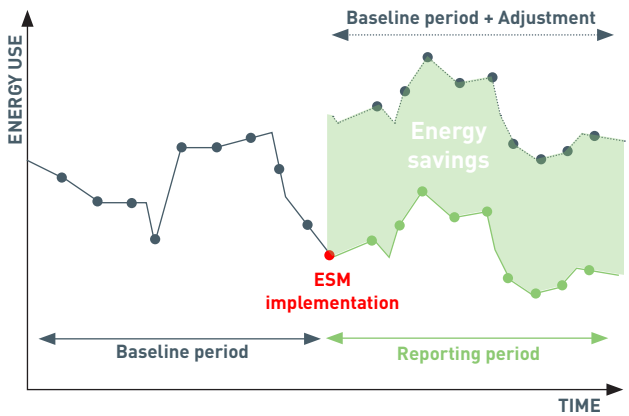
**Energy Savings = (Base-year Energy Use) - (Post-Retrofit Energy Use) +/- Adjustments**

«Adjustments» allow to assess two time periods according to a same set of conditions.
Adjustments can be separated into :

- «routine adjustments» for changes in parameters that can be expected to happen through the post-retrofit period and for which a relationship with energy use/demand can be identified (seasonal or cyclical changes - weather or occupancy variations).

- «non-routine adjustments» for changes in parameters that can not be expected to happen through the post-retrofit period.

This approach is simplified in the following diagram



# PROTOCOL
## INTRODUCTION


The **baseline** is defined as the period necessary to assess the dwelling energy consumption before the implementation of the ESM.
The **reporting period** is defined as the time after the implementation of the ESM.
**Once the ESM has been implemented**, the energy consumption for the dwelling is supposed to decrease. In order to calculate the savings, the baseline period has to be projected onto the reporting period timeline and to be ponderated by the same conditions (in order to be «adjusted»).

The relevancy of the savings assessment will be hugely correlated with rules for the Adjustment process.
IPMVP sets up different options to fix the boundaries of an evaluation. 4 options highlight different methodology to identificate savings according to different scale of parameters.

### 2.2. IPMVP OPTIONS.

The 4 IPMVP options define 4 scales and parameters basis to assess the savings for an ESM. The aim of this 4 options is to present different methodology to isolate/integrate parameters in order to calculate ESMs performances.

Options will be detailled in this document.
A simple overview highlights 4 major options :

- **Option A** : «isolation of a simple system and partial measurement, only of key-parameters, including stipulations on the other parameters.

- **Option B** : «isolation of a simple system and exhaustive measurement, including all parameters»

- **Option C** : «whole facility approach». Measures are taken at the dwelling's system or sub-system

- **Option D** : «computer simulations using a software calibrated on a data collection»

Every ESM user will have to define his level of assessment regarding the type of ESM he wants to implement.

### 2.3. IPMPVP MEASUREMENT AND VERIFICATION PROCESS STEPS.

As presented in introduction, IPMVP presents a process. An M&V assessment plan should cover different steps and topics.

The 2007 IPMVP version presents 13 major topics for a M&V plan to complete in order to have a better overview of the equation :

**Energy Savings = (Base-year Energy Use) - (Post-Retrofit Energy Use) +/- Adjustments**

The 13 descriptive steps/ topics are the following ones :

1. Project Intent
2. Selected IPMVP Option and Measurement Boundary
3. Baseline : Period, Energy and Conditions
4. Reporting period
5. Basis for Adjustment
6. Analysis Procedure
7. Energy prices
8. Meter Specifications
9. Monitoring Responsabilities
10. Expected Accuracy

# PROTOCOL
## INTRODUCTION

11. Budget
12. Report Format
13. Quality Assurance

The IPMVP-based adapted protocol for the AFTER Project will detail for every Pilot Site implementation these different topics.
The objective is to give a simple framework for these 13 topics focusing on the most relevant informations to collect in order to insure the quality of assessment for an ESM and its impact.

### 3. IPMVP : AFTER CHARACTERISTICS

AFTER will use the IPMVP has common basis to elaborate its own testing protocol. IPMVP is the most commonly used tool for assessing energy savings, nevertheless some particular points have to be precised concerning the AFTER Project on some points.

#### 3.1. DIVERSITY OF THE ESMS

The AFTER project collects different types of Energy Saving Measures. All these investment have to be assessed according to a same process in spite of their differences.
On ESM regarding a «contract review» (WP3) can't be assessed with the same tools used by an ESM associated with some small technical interventions on the heating system. AFTER focuses on economic, energy and social performance of the tested ESMs. These three main indicators will be less or more important regarding the characteristics of the ESMs. Other performance indicators will be also needed in order to improve the understanding of the efficiency for one particular ESM.
{cf. point 4. AFTER COMMON EVALUATION PROTOCOL: PILOT ESMs MATRIX}

As a consequence, WP3, WP4, WP5, WP6 and WP7 will not be assessed using the same indicators even if the process will be the same one, based on the IPMVP objectives and routines.
The IPMVP-based protocol for AFTER will be, in a first time, used as a simple guideline in order to detail the main step of a same protocol. All the specifications linked to the variety of ESMs will be detailed furthermore by WP leaders after the Pilot ESM and Pilot Sites selection regarding the nature of the different types of ESMs.

The objective is to allow the IPMVP-based to be as flexible as possible in order to be adapted for every different types of implementation.

#### 3.2. TIMELINE SPECIFITIES

Due to the diversity of ESMs collected within the AFTER Project, the relevancy of the reporting period are not the same for every implementation.

The implementation period has been determined to be one-heating season long in the AFTER Project. This time will not be sufficient to calculate the relevancy and performance of all the types of ESMs.
For example, some WP3 ESMs will need more time to see their energy impacts evaluated.
As investments are different by nature, energy savings calculation will be sometimes harder to assess.

# PROTOCOL
# INTRODUCTION


As a consequence the classic IPMVP should have to be completed by a complementary evaluation protocol focusing on the social performance and user reception of an ESM.

### 3.3. ASSESSING THE SOCIAL PERFORMANCE IN A RESIDENTIAL CONTEXT

AFTER common evaluation protocol for the testing «live» on sites will add to the original criterias of the IPMVP a «social performance» assessment protocol.

This new topic will be particularly focused on a simple questionnaire helping to better understand the impact of ESM for its users. Two aspects of this user-friendly performance will be particularly highlighted :

- the quality of use for every user determined by a common questionnaire.
- the impact on the user's invoice (rent+charges) which will help us to assess the tenants' economic tolerance regarding an ESM.

## 4. AFTER COMMON EVALUATION PROTOCOL: PILOT ESMs MATRIX

The Common Evaluation Protocol prepared by the AFTER Scientific partners proposes a common approach in order to evaluate the Pilot ESMs implemented during the testing phase of the project. This Common Evaluation Protocol presents a general process to follow the optimization solutions suggested for one ESM. Developping and explaining every step of the IPMVP, the CEP is a step-by-step method presenting an overview o how a measure can be assessed on site.

Due to the diversity of ESMs covered by the AFTER project, this process is of course a large approach of the assessment. The main elements to collect are presented in a global framework that will help to identify the information to collect in order to evaluate the efficiency of one optimization solution.
The Common Evaluation Protocol will be the general document and guideline to refer in order to have the same procedure between all the WPs. Nevertheless, this CEP will have to be customized regarding the heterogeneity of the Pilot ESMs collected and tested. In order to make easier this adaptation process to the characteristics of one ESM, Scientific partners realized a common Excel Matrix that will have to be customized and completed regarding the characteristics of every ESM.
This reporting tool is the operational translation of the Common Evaluation Protocol adapted for every ESM. The Excell Matrix is divided in several sub-tables, that will help to have a general view of the ESM, its optimization solutions and the way these optimization solutions will be implemented and measured during the testing phase.

Overview on the structure of this document:

### 4.1. SUB-TABLE #1: ESM IDENTIFICATION

The ESM identification aims at presenting the Pilot ESM implemented in the Pilot Site. This introduction to the ESM is the basis to highlight optimization solutions proposed both by Scientific leaders of the WPs and by participating SHOs.

# PROTOCOL
## INTRODUCTION


The content of this table is:

**1. Work Package for the ESM**
**2. Reference for this ESM in the original Inventory of the AFTER project.**
**3. Name of the ESM regarding the Typology developped during the first phase of the AFTER Project.**
**4. Description of the ESM and its technical aspects.**
**5. Initial investment cost in EUR.**
**6. Starting date for the implementation of the ESM.**

### 4.2. SUB-TABLE #2: PILOT SITE IDENTIFICATION

The Pilot Site identification will present the Pilot building where the Pilot ESM is implemented. This Pilot Site identification will be completed durng the testing phase thanks to the data collected by the participating SHOs.

The content of this table is:

1. **Name of the building**: Code-name of the building within the AFTER project.
**2. Adress of the building.**
**3. Year of construction.**
**4. Number of dwellings.**
**5. Number of stories.**
**6. Conditionned Floor Areas** (excluding common parts).
**7. Number of inhabitants in the building**: to be followed on the timeline of the baseline and the reporting period.
**8. Vacancy rate**: same remark than for the «Number of inhabitants».
**9. Tenants rents + charges**: this indicator will help to identify the economic repercussion of the optimization solution on the tenants.

### 4.3. SUB-TABLE #3: INTERVENTION SUGGESTED IN ORDER TO OPTIMIZE THE ESM

This table will help to highlight the optimization suggestions identified by the scientific partners of the project and by the Social Housing Organizations.
These optimization suggestion will propose a method adapted to the specificity of the ESM and of its place within the Work Package. The several optimization suggestions will be proposed in order using a priority order, the methods proposed by the scientific partners will lead to the identification and validation by the SHO of one optimization solution that will be implemented by the participating Social Housing Organization.

The content of the table is:

**1. Technical/Operating description of the intervention proposed in order to optimize the present performance of the ESM concerned.**
**2. Objectives of the intervention regarding economic/energy/social performance of the proposed intervention.**

The Optimization suggestions proposed will help to identify how what range of interventions can be implemented on one building in order to improve a special type of ESM.
They will be precised with more technical inputs on the last table of the Matrix: the intervention table.

# PROTOCOL
## INTRODUCTION


### 4.4. SUB-TABLE #4: ACTIONS SUGGESTED IN ORDER TO OPTIMIZE THE ESM

This table objective is to describe the several actions and adjustments implemented in order to optimize the ESMs.
This action table separates the different technical recommandations and the indicators that will help SHOs and scientific partners to assess the efficiency of the optimized measure.

The action is divided into several steps that will allow to understand the complete process settled thanks to it.

The content of this table (step-by-step) is:

**1. Description of the action:** the implemented intervention is described with its technical and concrete aspects. Technical documentation will be added and attached to this description.
**2. Equipment/part of the system impacted:** identification of the part of system impacted by the action. The objective is to identify the general system/ equipment impacted by the action (heating system, ventilation system, etc...) and to specify what particular element of this system will be modified/adjusted thanks to the intervention.
**3. Procedures and management routines impacted by the action:** identification of the management and operational aspects modified due to the intervention. The contractual aspects, the staff organization consequences of the intervention will be mentioned.
**4. Parameters measurements:** This row will indicate the relevant indicators to collect and evaluate in order to assess the efficiency of the ESM.
This «Parameter measurements» will indicate the IPMVP option selected to measure the parameters, the parameter measured and the time range between every measurement.
5. **Metering characteristics and points:** Linked with the questions of the parameters measured, the metering characteristics that will help to measure the identified parameters will be indicated. Schemes will be added to precise this metering system.
**6. Related documents on Dropbox**

For every parameter indicated in the table, a measurement table will be integrated to the Excel Matrix in order to follow the evolution of the parameter during the testing phase.

cf. point 12 of the part «Tool» of this Common Evaluation Protocol.

The final objective is, of course, to measure economic, social and energy objectives

## CONCLUSION

The AFTER Common Evaluation Protocol is separated in two elements:

- one guideline translating the main aspects of the IMPVP in the AFTER context and presenting a step-by-step framework in order to lead every partner to identify and collect the relevant information regarding an optimized ESM.
- one reporting format (the EXcel file) allowing to report the collected data and to precise the different interventions implemented in order to optimize one ESM.

This duality is explained by the diversity of our ESMs: if one document can be define as a Common Evaluation Protocol that propose a same process for all these ESMs, the second one is more adapted to the reality and the

# PROTOCOL
## INTRODUCTION


characteristics of every ESM.

The final 18 completed Evaluation Protocol will offer a complete approach for the interventions concerning the management and the maintenance of the existing social housing stock. As the AFTER Project concerns different types of interventions on existing buildings, the addition of these adapted-Evaluation Protocol will lead to a good overview of the different interventions that can be done related to a specific ESM.

The optimization solutions implemented by the Social Housing Organizations are detailled with sub-actions, identified impacts and parameters requested to measure its efficiency.This work will constitute a strengthened guideline covering potential interventions on our topics.
As a consequence, the completed versions and Excel file for the 18 ESMs will provide an adapted check list for other Social Housing Companies describing the actions implemented on the

IPMVP
INTERNATIONAL PERFORMANCE MEASUREMENT AND VERIFICATION PROTOCOL

# TOOL

Please complete the follow tables step-by-step with all the requested information regarding your Pilot Building and your Pilot ESM.

The AFTER Handbook (D2.3) will help you to identify the calculation criteria, if needed, to complete all the lines of these tables.
A more complete description of the RCx step-by-step process can be found in Appendix B page 34 of this document.

# PROTOCOL
## ENERGY EFFICIENCY MEASUREMENT PROTOCOL

## 0. IDENTIFICATION OF THE BUILDING

### Name of the ESM :

### WP ...

SHO :

Country :

Adress of the building :

Year of construction of the building :

Number of dwellings :

Surface of the ESM :

Number of inhabitants :

Responsible :

Contact :

Collected documents :

# PROTOCOL
## ENERGY EFFICIENCY MEASUREMENT PROTOCOL

## 1. OPTIMIZATION PROJECT INTENT

**First Step** : Present a global overview on the Energy Saving Measure implemented in the building before to start the implementation.

| | |
|---|---|
| **1.1 Description of the Energy Saving Measure and the suggested optimization solutions.** | - Which part of the building/system/equipment is implied?<br>- Technical description of the energy saving measure focusing on O&M aspects.<br>- Optimization solutions proposed |
| **1.2 Intended results for the optimization solutions** | - Objectives<br>- Targets<br>- Type of Consumption impacted.<br>- Figures (when possible) |

# PROTOCOL
## ENERGY EFFICIENCY MEASUREMENT PROTOCOL

## 2. IPMVP OPTION

**Second Step** : Select which measurement boundary will be used to determine energy savings.
This selection has to be done according to the different criteria of the IPMVP from option A to option C. Option D will not be retained as relevant for the AFTER Project.
After having selected your option, list the parameters you'll analyzed.

| | IPMVP OPTION | HOW SAVINGS ARE CALCULATED | TYPICAL APPLICATIONS |
|---|---|---|---|
| Ⓐ | **RETROFIT ISOLATION : KEY PARAMETER MEASUREMENT**<br><br>Savings are determined by field measurement of the key performance parameter(s) which define the energy use of the affected system(s) and the success of the project.<br><br>Measurement frequency ranges from short-term to continuous, depending on the expected variations in the measured parameter, and the lenght of the reporting period.<br><br>Parameters not selected for field measurement are estimated. Estimates can based on historical data, manufacturer's specifications, pr engineering judgment. Documentation of the source or justification of the estimated parameter is required. The plausible savings error arising from estimation rather than measurement is evaluated.<br><br>Indicated for equipment renovation with the same behaviour. | Engineering calculation of baseline and reporting period energy from :<br><br>- short-term or continuous measurements of key operating parameter(s)<br>- estimated values<br><br>Routine and non-routine adjustments as required. | - the performance of only the systems affected by the ESM is of concern either due to the responsabilities assigned to the parties in a performance contract or due to the savings of the ESM being too small to be detected using option C.<br><br>- interactive effects between ESM with other equipment can be measured to be non significant<br><br>- isolation of the ESM from the rest of the building and stipulation may avoid possible difficult non-routine Baseline Adjustments for the future changes.<br><br>- independent variables that affect energy use are not complex or expensive to monitor<br><br>- submeters already exist to isolate energy use of systems<br><br>- meters added for isolation purposes will be used for other purposes such as operational feedback or tenant billing<br><br>- uncertainty created by stipulations is acceptable<br><br>- continued effectiveness of the ESM can be assessed by routine visual inspection of stipulated parameters |

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| | | | |
|---|---|---|---|
| B | **RETROFIT ISOLATION : ALL PARAMETER MEASUREMENT**<br><br>Savings are determined by field measurement of the energy use of the affected system.<br><br>Measurement frequency ranges from short-term to continuous, depending on the expected variations in the savings and the lenght of the reporting period.<br><br>Indicated for behavior change in the use of equipment. | Short-term or continuous measurements of baseline and reporting-period energy, and/or engineering computations using measurements of proxies of energy use.<br><br>Routine and non-routine adjustments as required. | - interactive effects between ESM or with other equipment can measured or assumed to be immaterial<br><br>- isolation of the ESM from the rest of the building and stipulation may avoid possible difficult non-routine Baseline Adjustments for the future changes.<br><br>- independent variables that affect energy use are not complex or expensive to monitor<br><br>- submeters already exist to isolate energy use of systems<br><br>- meters added for isolation purposes will be used for other purposes such as operational feedback or tenant billing |
| C | **WHOLE FACILITY**<br><br>Savings are determined by measuring energy use at the whole facility or sub-facility level.<br><br>Continuous measurements of the entire facility's energy use are taken throughout the reporting period.<br><br>Indicated for energy efficiency measurements applications with total energy savings potential higher than 10%. | Analysis of the whole facility baseline and reporting period (utility) meter data.<br><br>Routine adjustments as required, using techniques such as simple comparison or regression analysis.<br><br>Non-routine adjustments as required | - energy performance of the whole facility is to be assessed, not just the ESM<br><br>-different types of ESMs in one building<br><br>- ESM involve diffuse activities which cannot easily be isolated for the rest of the facility, such as operator training or wall and window upgrades<br><br>- savings are large enough to be separated from noise in the baseyear data during time of the monitoring<br><br>- interactive effects between ESMs or with other equipment is substantial making isolation techniques of Options A and B excessively complex<br><br>- reasonable correlations can be found between energy use and other indepent variables |

| | |
|---|---|
| **2.1 Option** | |
| **2.2 Parameters measured** | |
| **2.3 Interactive effects beyond the measurement boundary** | |

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## 3. BASELINE PERIOD

**Third Step** : Develop the baseline period and conditions in order to assess the future energy savings.
The baseline period is the time necessary to be representative of the dwelling energy consumption before the implementation of an ESM.
In order to assess the energy savings, an energy audit is often necessary in order to gather and to the necessary documentation the determine the conditions of the baseline period.

| | |
|---|---|
| **3.1 Identification of the baseline period** | |
| **3.2 All baseline energy data** | - Type of energy.<br>- Time range between the evaluation.<br>- Energy Consumption. |
| **3.3 Independent variable data coinciding with the energy data** | - Legal temperature within the building.<br>- HDD. |
| **3.3 Static factors coinciding with the energy data** | - Occupancy.<br>- Space being heated.<br>- Change in the power or amount or use of equipment. |

# PROTOCOL
## ENERGY EFFICIENCY MEASUREMENT PROTOCOL

## 4. REPORTING PERIOD

**Fourth Step** : Select a reporting period. For the AFTER project, this period is intented to cover one heating season. Nevertheless, this reporting period should be precized and adapted according to every ESM.

| | |
|---|---|
| **3.1 Identification of the baseline period** | |
| **3.2 All baseline energy data** | - Type of energy.<br>- Time range between the evaluation.<br>- Energy Consumption. |
| **3.3 Independent variable data coinciding with the energy data** | - Legal temperature within the building.<br>- HDD. |
| **3.3 Static factors coinciding with the energy data** | - Occupancy.<br>- Space being heated.<br>- Change in the power or amount or use of equipment. |

# PROTOCOL
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## 5. BASELINE ADJUSTMENT

**Fifth Step** : List the sets of conditions to which the ESM will be adjusted. The objective is to identify what changes could impact the energy savings induced by the ESM.

| | |
|---|---|
| **5.1 Wheater adjustment** | - HDD. |
| **5.2 Modified space being heated or air conditionned** | |
| **5.3 Changes in the power/amount/use of equipments** | |
| **5.4 Changes in occupancy** | |
| **5.5 Changes in the building envelope characteristics (new insulation, windows, doors, air tightness)** | |

# PROTOCOL
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## 6. ANALYSIS PROCEDURE

**Sixth Step** : Specify the exact data analysis, procedure and assumptions to be used in each savings report. For each model used, report all of its terms and the range of variables over which is valid.

| | | |
|---|---|---|
| **6.1 Step #1** | - HDD. | |
| **6.2 Description of the action** | | |
| **6.3 Equipment/Part of the system impacted** | | |
| **6.4 Procedures and management routines impacted by the action** | | |
| **6.5 Parameters measurement** | IPMVP Option | |
| | Parameter measured | |
| | Time Range | |
| **6.6 Metering characteristics and points** | | |
| **6.7 Related documents on Dropbox** | | |

# PROTOCOL
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## 7. ENERGY PRICES

**Seventh Step** : Indicate the energy prices that will be used in order to associate a financial value with energy savings and the the way to integrate them.

| | |
|---|---|
| **7.1 Energy(ies) concerned by the ESM** | |
| **7.2 Evolution of the concerned energy prices** | - Time range.<br>- Baseline period evolution.<br>- Reported period evolution. |
| **7.3 Necessity to adjust the savings to the energy prices variation** | YES/NOT |
| **7.4 Adjusted consumption spendings**<br>Equation to complete. | |

# PROTOCOL
## ENERGY EFFICIENCY MEASUREMENT PROTOCOL

## 8. METER SPECIFICATIONS

**Eighth Step** :Specify the different steps to complete a metering of the different energy consumptions.

| | |
|---|---|
| **8.1 Metering points list** | |
| **8.2 Period of metering** | |
| **8.3 Meter characteristics and logged parameters** | |
| **8.4 Meter reading process** | - Steps.<br>- Witnessing.<br>- Deliverables. |
| **8.5 Routine calibration process**<br>If relevant | |

# PROTOCOL
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## 9. MONITORING RESPONSABILITIES.

**Ninth Step** : List the different responsabilities for every different task of an ESM implementation on pilot site. These responsabilities focus on the different steps of the process and will allow every partner to identify the relevant stakeholder within every SHO.

| | Tasks | Contact |
|---|---|---|
| **9.1 Coordination** | | |
| **9.2 Recording Energy Data** | | |
| **9.3 Report, adjustment and analysis of the Energy Data** | | |
| **9.4 Recording the users feedback** | | |
| **9.5 Report, adjustment and analysis of the users feedback** | | |

# PROTOCOL
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## 10. EXPECTED ACCURACY.

**Tenth Step :** The uncertainty is a key element in the calculation of an energy saving. The protocol will present the different potential sources of uncertainty and

| | |
|---|---|
| **10.1 Measurements errors**<br>Metering inaccuracy or errors in recording. | |
| **10.2 Non-coverage and non-response errors**<br>Metering excludes part of the population or participation is missing. | |
| **10.3 Modeling errors**<br>Due to the selection of models and adjustments to the data to take into account differences between the baseline and the test period. | |
| **10.4 Random error measurement**<br>TO COMPLETE | |

# PROTOCOL
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## 11. BUDGET.

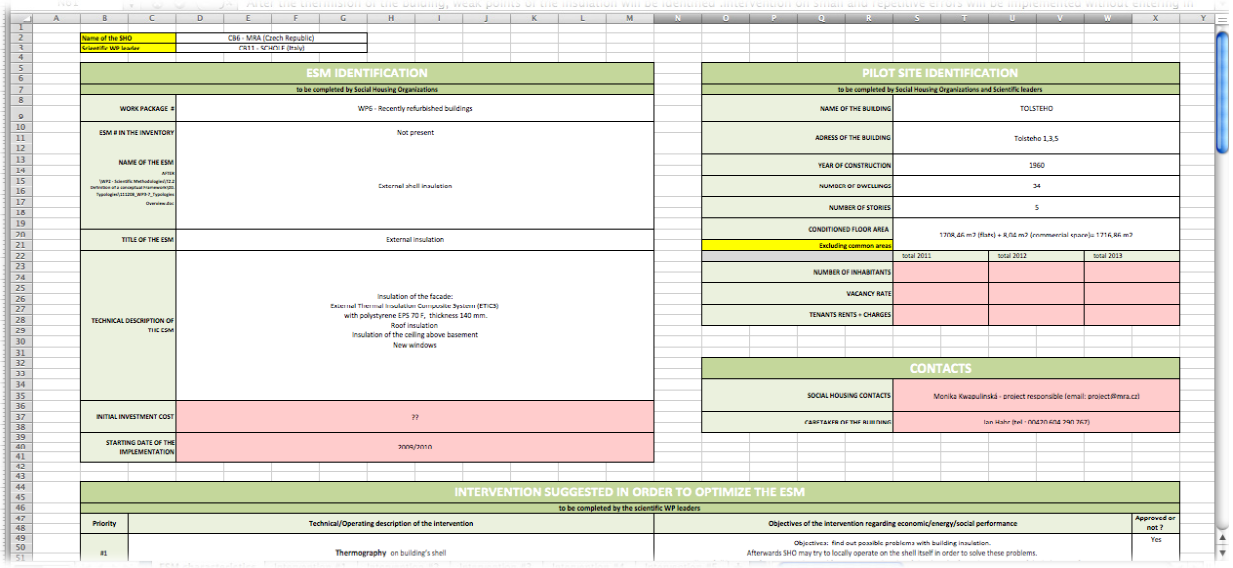
**Eleventh Step** : Define a budget for the savings determination. This budget should include different lines : initial investment costs for the ESM, O&M costs during the reporting period, staff costs relating to the direct investment, metering set-up costs, staff costs for savings determination.

| | |
|---|---|
| **11.1 Initial investment costs for the optimized ESM**<br>Details. | |
| **11.2 O&M costs during the reporting period**<br>Details. | |
| **11.3 Staff costs relating to the direct investments**<br>Details. | |
| **11.3 Metering set-up costs**<br>Details. | |
| **11.4 Staff costs for savings determination**<br>Details. | |

# PROTOCOL
## ENERGY EFFICIENCY MEASUREMENT PROTOCOL

## 12. REPORT FORMAT.

**Twelfth Step** : Define a format to present how energy savings results will be documented and disseminated.
cf. Pilot Site Evaluation Excel file.



| | |
|---|---|
| Name of the SHO | CB6 - MRA (Czech Republic) |
| Scientific WP leader | CR11 - SCHEV F (Italy) |

**ESM IDENTIFICATION**
to be completed by Social Housing Organizations

| | |
|---|---|
| WORK PACKAGE # | WP6 - Recently refurbished buildings |
| ESM # IN THE INVENTORY | Not present |
| NAME OF THE ESM | External shell insulation |
| TITLE OF THE ESM | External insulation |
| TECHNICAL DESCRIPTION OF THE CSM | Insulation of the facade:<br>External Thermal Insulation Composite System (ETICS)<br>with polystyrene EPS 70 F, thickness 140 mm.<br>Roof insulation<br>Insulation of the ceiling above basement<br>New windows |
| INITIAL INVESTMENT COST | ?? |
| STARTING DATE OF THE IMPLEMENTATION | 2009/2010 |

**PILOT SITE IDENTIFICATION**
to be completed by Social Housing Organizations and Scientific leaders

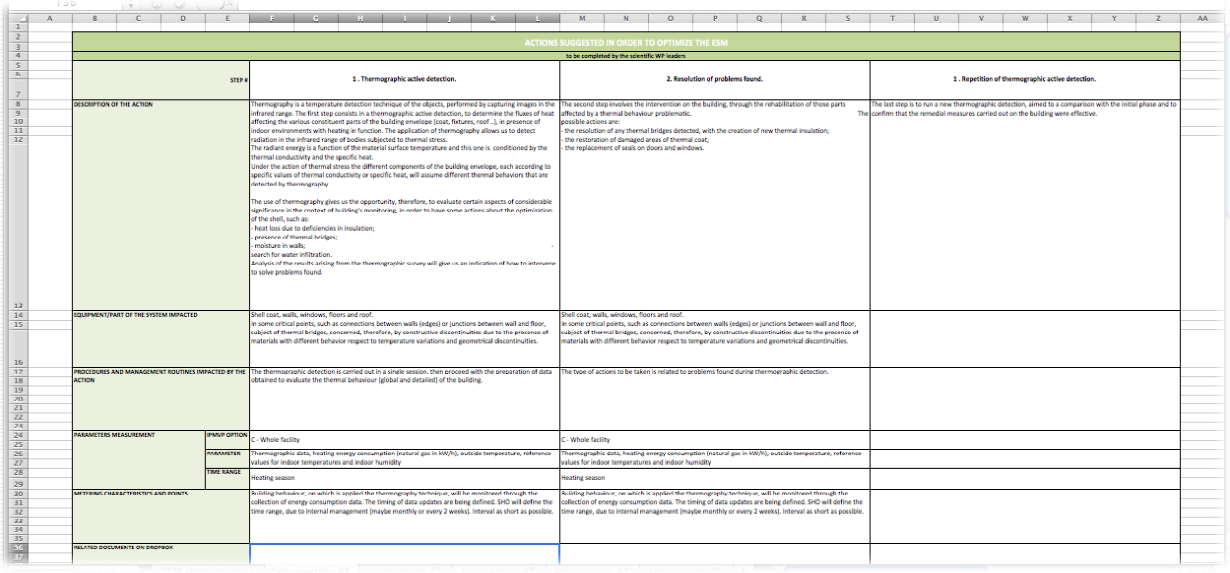
| | | | |
|---|---|---|---|
| NAME OF THE BUILDING | TOLSTEHO | | |
| ADRESS OF THE BUILDING | Tolsteho 1,3,5 | | |
| YEAR OF CONSTRUCTION | 1960 | | |
| NUMBER OF DWELLINGS | 34 | | |
| NUMBER OF STORIES | 5 | | |
| CONDITIONED FLOOR AREA | 1708,46 m? (flats) + 8,00 m? (commercial space)= 1716,46 m? | | |
| Excluding common areas | | | |
| | total 2011 | total 2012 | total 2013 |
| NUMBER OF INHABITANTS | | | |
| VACANCY RATE | | | |
| TENANTS RENTS + CHARGES | | | |

**CONTACTS**

| | |
|---|---|
| SOCIAL HOUSING CONTACTS | Monika Kwapulinská - project responsible (email: project@mra.cz) |
| CARETAKER OF THE BUILDING | Jan Hahr (tel : 00420 604 290 767) |

**INTERVENTION SUGGESTED IN ORDER TO OPTIMIZE THE ESM**
to be completed by the scientific WP leaders

| Priority | Technical/Operating description of the intervention | Objectives of the intervention regarding economic/energy/social performance | Approved or not ? |
|---|---|---|---|
| #1 | **Thermography** on building's shell | Objectives: find out possible problems with building insulation.<br>Afterwards SHO may try to locally operate on the shell itself in order to solve these problems. | Yes |



**ACTIONS SUGGESTED IN ORDER TO OPTIMIZE THE ESM**
to be completed by the scientific WP leaders

| STEP # | | 1 . Thermographic active detection. | 2. Resolution of problems found. | 3 . Repetition of thermographic active detection. |
|---|---|---|---|---|
| DESCRIPTION OF THE ACTION | | Thermography is a temperature detection technique of the objects, performed by capturing images in the infrared range. The first step consists in a thermographic active detection, to determine the fluxes of heat affecting the various constituent parts of the building envelope (coat, fixtures, roof ...), in presence of indoor environments with heating in function. The application of thermography allows us to detect radiation in the infrared range of bodies subjected to thermal stress.<br>The radiant energy is a function of the material surface temperature and this one is conditioned by the thermal conductivity and the specific heat.<br>Under the action of thermal stress the different components of the building envelope, each according to specific values of thermal conductivity or specific heat, will assume different thermal behaviors that are detected by thermography.<br><br>The use of thermography gives us the opportunity, therefore, to evaluate certain aspects of considerable significance in the context of building's monitoring, in order to have some actions about the optimization of the shell, such as:<br>- heat loss due to deficiencies in insulation;<br>- presence of thermal bridges;<br>- moisture in walls;<br>search for water infiltration.<br>Analysis of the results arising from the thermographic survey will give us an indication of how to intervene to solve problems found. | The second step involves the intervention on the building, through the rehabilitation of those parts affected by a thermal behaviour problematic.<br>possible actions are:<br>- the resolution of any thermal bridges detected, with the creation of new thermal insulation;<br>- the restoration of damaged areas of thermal coat;<br>- the replacement of seals on doors and windows. | The last step is to run a new thermographic detection, aimed to a comparison with the initial phase and to confirm that the remedial measures carried out on the building were effective. |
| EQUIPMENT/PART OF THE SYSTEM IMPACTED | | Shell coat, walls, window, floors and roof.<br>In some critical points, such as connections between walls (edges) or junctions between wall and floor, subject of thermal bridges, concerned, therefore, by constructive discontinuities due to the presence of materials with different behavior respect to temperature variations and geometrical discontinuities. | Shell coat, walls, windows, floors and roof.<br>In some critical points, such as connections between walls (edges) or junctions between wall and floor, subject of thermal bridges, concerned, therefore, by constructive discontinuities due to the presence of materials with different behavior respect to temperature variations and geometrical discontinuities. | |
| PROCEDURES AND MANAGEMENT ROUTINES IMPACTED BY THE ACTION | | The thermographic detection is carried out in a single session, then proceed with the preparation of data obtained to evaluate the thermal behaviour (global and detailed) of the building. | The type of actions to be taken is related to problems found durine thermoraphic detection. | |
| PARAMETERS MEASUREMENT | IPMVP OPTION | C - Whole facility | C - Whole facility | |
| | PARAMETER | Thermographic data, heating energy consumption (natural gas in kW/h), outside temperature, reference values for indoor temperatures and indoor humidity | Thermographic data, heating energy consumption (natural gas in kW/h), outside temperature, reference values for indoor temperatures and indoor humidity | |
| | TIME RANGE | Heating season | Heating season | |
| METERING PARAMETRIZATION AND POINTS | | Building behaviour, on which is applied the thermography technique, will be monitored through the collection of energy consumption data. The timing of data updates are being defined. SHO will define the time range, due to internal management (maybe monthly or every 2 weeks). Interval as short as possible. | Building behaviour, on which is applied the thermography technique, will be monitored through the collection of energy consumption data. The timing of data updates are being defined. SHO will define the time range, due to internal management (maybe monthly or every 2 weeks). Interval as short as possible. | |
| RELATED DOCUMENTS ON DROPBOX | | | | |

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## 13. QUALITY ASSURANCE.

**Thirteenth Step** : Specify a common control framework used during the implementation phase in order to ensure effective operation and correct cost account.

| | |
|---|---|
| **13.1 Time range and routines for Quality checks.**<br>Monthly/weekly, etc... Major Steps. | |
| **13.2 Reviewing responsabilities** | |

# TENANTS
## AFTER SCIENTIFIC METHODOLOGY

**Feedback on Energy Efficiency Measures within the buildings have higlighted some issues regarding the link between energy performance and tenants' involvement.**
**Among the main complaints met regarding this topic we can find the following ones: gap sbetween the expected results and the reality (both regarding consumptions and comfort), complexity regarding the appropriation of the dwelling and its engineering by the user, low impact on effective economic savings for the tenant (due to the additional management and maintenance costs for the systems)etc. These deficiencies lead us to integrate deeper in the AFTER project, the tenants' involvement topic.**

**Indeed, tenants'awareness and information towards users appear as an essential qualitative guarantee regarding the energy performance. Tenants are not passive witnesses of the technical solutions allowing energy savings. They are active actors and their ability to integrate and to apply the technical solutions can be a key element for the success of our ESMs. As a consequence, tenants need to be involved in the AFTER process in order to secure the results of the testings.**
**The objective is mainly to supervize and create best practices linked with a recurrent pit fall regarding energy performance : the increasing transfert of responsabilty to the tenant regarding the good use of its housing technologies.**

How to imply the user regarding the energy efficiency performance of its dwelling?

Energy savings in the buildings are considered as a major stake for a sustainable development. In order to sustain this objective, an approach oriented towards the tenants need to be complementary with the technical and material improvements and investments regarding thermic efficiency.
Potential new fields for energy savings can be highlighted in the grey zone between the building (and its technical aspects) and the actions of its users. This approach is essential in order to square with the daily management and routine of the building and its main stakeholder the tenants.
The objective of the enclosed «Tenants Survey» Methodology is to better understand, within the AFTER project, what is the integration of the tested ESMs by the tenants, and to identify how it can be improved.

### 1. TENANTS' AWARENESS: A KEY-ELEMENT FOR SUCCESS IN ENERGY EFFICIENCY STRATEGIES

Refurbishments and new constructions have to be planned upstream regarding maintenance and management aspects. Tenants' habits, uses and behaviours have to be assimilated and oriented in order to guarantee the efficiency of the new Energy Saving Measures and their integration by the audience targeted by these improvements.
Indeed, technical improvements need to be completed thanks to a special attention towards the tenants. The impacts on the use of the building and the tenants interaction with the new technical innovations is very important to improve the energy impact of the innovations and optimization implemented and to secure their quality on a long term.

# TENANTS
# AFTER SCIENTIFIC METHODOLOGY

### 1.1. AFTER METHODOLOGY REGARDING TENANTS: INTRODUCTION

This investment on tenants involvement regarding the energy savings is essential to tackle the energy efficiency topic in the building. An approach focusing not only on the technical side but also on the social one has to be developed in order to cover up the complexity of this stake. An ESM that is bad understood or that is not well managed by the concerned tenants may be inefficient and costly.
As a consequence, the tenants survey is one element of the quality approach for our experimental process. In concert with the traditional questions of construction quality and on the conception of the buildings and their systems, Energy Saving Measures within the buildings need also to be analysed and developed on a larger a more complex scale.

AFTER concerns the energy performance within the European Social Housing Stock. Due to the particular characteristic of the audience concerned and the specificities of the «social» mission for our participating SHOs, the tenants topic has to be processed very carefully. The particular responsibility of the SHOs regarding their tenants in terms of quality and efficiency of the buildings, the presence of low-income tenants and the correlated risks (fuel poverty, etc.) has to be taken in account in our approach.
Thereof, a special focus has to be put on the tenants question in order to ensure that the measures tested in AFTER are sustainable (comfort requirement) for the tenants, affordable (financial requirement), understandable (information requirement) and can be integrated within a quality process implying all the stakeholders involved (collaboration requirement).

Thereof, the energy performance measurement on the Pilot Sites of the AFTER Project will be integrated and comprehended according other dimensions that will influence the success of our process, such as:

- daily routines of the tenants regarding their dwellings.
- the awareness of the tenants regarding the sustainable stakes and their commitment.
- the link of the technology proposed to the social norm and the social perception of the dwellings.

The ambition of this approach aims at identifying and objectivizing as much as we can, and using a pragmatic methodology, some very subjective aspects that will, nevertheless, influence our results.

At a larger scale, observing and detailing this tenants' topic will help us to develop a fruitful basis and a method for the future projects.
Indeed, the consideration of the tenants' behaviour is a qualitative information to integrate in the general conception of the energy saving measures and their implementation. The «hardware» aspects (technical implementation, following of the consumption and metering) need to be correlated with more «software» aspects such as the uses. The innovation and its savings must be analysed on a more subjective plan integrating an approach playing close attention to the behaviours and the comfort of the tenants.

As feedbacks on the tenants' awareness and behaviours are often a neglected variable when we talk about the energy efficiency of the buildings.
In order to reach this goal, we have developed, within the AFTER project, a simple tool in order to collect and analyse the feedback provided by the tenants regarding their understanding of the ESMs and they integrate them in their daily lives.

### 1.2. AFTER METHODOLOGY REGARDING TENANTS: PRESENTATION OF THE METHODOLOGICAL PROCESS

The feedback on energy consumption data and the providing of tips and hints for saving energy are not enough to know the tenants' satisfaction and to enhance the usability of the ESM. To be a success, the project must listen the tenants and establish a dialogue about the ESM.
The project must receive the agreement of the people to avoid behaviours that would defeat the effectiveness

# TENANTS
## AFTER SCIENTIFIC METHODOLOGY

of measures. Consultation between the housing provider and tenants can improve their relationships and participate in the project's success. For that reason a tenant survey process has been planned and will be conducted.

Since it is important again to have the information for the baseline and the reporting period, the survey has to be conducted before the work, during and after the realisation of the work.
The survey provides a qualitative assessment complementary to that of the savings in energy, including assessing the gains for tenant comfort.

**Why before?**

Therefore, it is important to plan activities to motivate the tenants to make use of the provided ESM.
First of all, it is recommended to get in touch with the tenants in an early stage of the project to explain the idea and the application of the works that will be implemented. Furthermore, information events, workshops and trainings can be realised in order to raise the interest of the tenants in using the ESM.
Consult tenants before implementing measures that can help identify the refusal, and guide the project differently to give him every chance to succeed.

**Why during?**

The mid-term evaluation serves to get information from tenants about their first experiences and/or from staff about their experiences concerning the pilot maintenance and usability activity. Consultation with tenants during the implementation of measures can help identify bottlenecks and, if necessary, to explain again, reorient the project.

**Why after?**

In contrast to the consumption data, for example, energy behaviour and awareness can be influenced by many other factors, too, such as general changes in the awareness of ecological aspects and personal interests or exceptional occurrences.
The survey has to be conducted during all the establishment of the ESM to measure the impact of the ESM.
Obtain feedback from tenants after the introduction of the measure will ensure the relevance of this measure and learn from it.

**How?**

There are different field instruments to conduct a survey (postal/paper-based, telephone interview, face to face interview, online survey). The suitability depends on the tenants and further basic conditions, but in general a more personal form of conducting the survey will raise the motivation to participate respectively will lower the non-compliance of the respondents.

From this point of view, in the AFTER project face to face interviews are recommended (good applicable because of small number of respondents; but need of interviewers, record of data if it's not computer assisted).
Telephone interviews are also appropriate (but need of interviewers, of very clear and easy comprehensible questions, of record of data if it's not computer assisted).
Portal users can also be interviewed online (no data entry necessary, but need of programming of very clear and attractive survey; non-users of the portal will not be reached).

Postal interviews are less recommended for the AFTER project (most non personal form of interviewing; need of very clear structure and filter questions, of data entry; costs for print). The content of a cover letter also is important. If another interview form shall be used, the following contents should be mentioned as introduction when asking the tenant to participate on the survey.
This introduction should contain information about the importance of the provided ESM and the project, the relevance and the main topics of the survey, the

# TENANTS
# AFTER SCIENTIFIC METHODOLOGY

importance of the participation of every single tenant to increase the significance of the data, warrant of data privacy, should invoke the tenant's help for evaluating the ESM, show advantages for the tenant and mention rewards as incentives.

## 2. AFTER TENANTS' AWARENESS HIGHLIGHTS: SATISFACTION+BEHAVIOR

The implementation of the Tenants' Survey will have to follow a process focusing both on the behavioural and the satisfaction aspects of the Pilot ESMs.

### 2.1. AFTER PROJECT: ENERGY SAVING MEASURES TESTED BOTH ON SATISFACTION AND BEHAVIORAL ASPECTS

Conceptually, the Tenants' Survey plan is divided in two parts:

- one part regarding the behaviour of the tenants regarding energy management aspects.
- one part regarding the satisfaction of the tenants and their understanding of the implementation lead on their dwelling/building.

The idea is to integrate in a same approach both:

- the upstream aspect (the lifestyle of the tenants and the human aspects that will influence the implementation of the ESM and its results).
- the downstream aspects (the assimilation of the ESM on a tenants point of view and its potential durability).

The objective of the behavioural approach aims at :

- identifying some significant and quantitative data regarding the tenants within the building and the structure of the household in order to circumscribe the limits of the public impacted by the ESM.
- qualifying the level of sensitivity an the general understanding of the tenants involved during the implementation regarding the sustainable and the energy awareness. This effort will help us to see how this subjective and knowledge aspects may influence the results.
- receiving a feedback on the notion of «needs» regarding the energy consumption and the interactions with the comfort aspects.
- offering a mental cartography of the significant routines that will surround the integration of the ESM.

This behavioural approach will offer both an overview of the general perception among the tenants for the environmental aspects of the project and their habits about it. On a second hand, this approach is necessary to identify, on an individual level, the particular behaviours and the specific tenants that may have difficulties with the experimentation due to several factors.
As a consequence, the approach is both an informative and a preventive tool that will bring a knowledge of the human and social context surrounding our testing live on Pilot Sites.

The objective of the satisfaction is to test the perception of our testing and to see how they are identified. This approach is essential to obtain a softer quality indicator for the efficiency of our ESMs, but also to identify if they are well understood by the users and well used.
Before starting a tenants survey on satisfaction (as the questionnaire is attached) the scope and the focus of "satisfaction" with the ESMs at stake need some clarification.

This survey aims at covering a large sample of what we can include in the satisfaction aspects regarding the energy performance and its impact on the daily life.
The satisfaction questionnaire will identify several levels of satisfaction:

- the general satisfaction and perception of the works done during the implementation, their financial impacts, etc.
- the satisfaction regarding perceived comfort by the

# TENANTS
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tenants after the implementation of the ESM.
- the satisfaction regarding information delivered to the tenants. This part of the survey will give us tips on how to communicate about the energy performance and the saving measure.

This part aims at offering both a feedback about the quality and the efficiency of our on own efforts but will also provide some corrective tips about the way to adapt of level and tools of communication towards tenants.

### 2.2. AFTER PROJECT: A DIVERSITY OF ENERGY SAVING MEASURES

After this introduction to the logics and the content of the AFTER Tenants Survey, we have now to precise the fieldwork for the implementation of this tool.

Of what kind of "works" do we speak?
AFTER looks into low investment activities and focuses on optimization measures of technical and non technical kind. There won't be mayor investments. (typical investments within the AFTER project could be, for example, the installation of additional monitoring systems.

AFTER confronts the tenants with technical and non technical ESMs. WP 7, WP 6 and WP 5 primarily deal with technical ESMs which can be summarized as follows:

WP 7 deals with new LEB with a highly insulated building shell as well as sophisticated ventilation and heat supply systems.
WP 6 looks at (global) retrofitting of the shell and the systems - thus including elements of WP 7.
WP 5 looks at new heating, ventilation and water heating systems.
Tenants will have to live and deal with these ESMs in their daily life. They have to understand, accept and correctly use them. The tenants' survey on satisfaction will reflect and assess these ESMs and the understanding and integration of these technical aspects by tenants. The objective is to see how far can go the practical involvement of the tenants in front of technical changes and innovations regarding the building and its system. How it's perceived on technical evolution on the concrete aspects of everyday life.

AFTER also covers explicitly non-technical ESMs as described in WP 4 and WP 3.
WP 4 looks into tenants' behaviour in respect to the proper application of the ventilation system of WP 5.
WP 3 looks into (all kinds) of contractual relations with tenants. Some are mentioned in WP 3 and in the methodological note above. These relations of course are not limited to WP 3. WP 3 also looks into the role of ICT solutions. ICT solutions itself are technical ESMs either already part of an ESM or a means for optimization activities.

Relations with tenants, activities addressing tenants offer a broad range of "eco-empowerment". They are ESMs with optimization potential and mainly are of non-technical kind. Although they are mentioned in WP 3 these ESMs are relevant for WP 4-7, too.
All executed and possible eco-empowerment activities need to be listed- they can be found in WP 3 but also in WP 7 and the other WPs.

Also these non-technical ESMs will be checked in the tenants' survey on satisfaction and the quality-assessment.

As tenants play an important role in applying the ESMs, the proper use of ESMs should be investigated as well. Therefore it should be considered if a tenants' survey on the habits and behaviour in respect to the ESMs is required.

Relevant fields of investigation are for example heating and ventilation behaviour, air conditioning, required room temperature, use of the windows, warm water consumption for persons and washing, energy consumption for drying, interest in tenant's portal for current energy consumption. All variables controlled

# TENANTS
# AFTER SCIENTIFIC METHODOLOGY

and impulsed by the tenants and that may influence the scientific results for the Pilot Sites testing.

On the other hand, tenants surveys will not be appropriate for all ESMs (e.g. tenants will not be able to tell you much about the effects after exchanging a boiler) respectively their optimizations.
Therefore, it should be clarified for which measures and at which pilot sites such surveys need to be introduced. The Annex included in this «Tenants Survey» methodology identify, after a collective discussion between all the AFTER partners, what Pilot ESMs may need special feedback on satisfaction or on uses.

## 3. AFTER TENANTS' AWARENESS: IMPLEMENTATION OF THE TENANTS SURVEY

The way to implement the tenants survey has to be as flexible and as simple as possible for the Social Housing Organization that will be also focused on the technical aspects of our testing phase.

This tenants survey and information process will be mainly organized on two different steps:

- questionnaires oriented towards behaviour and satisfaction topics.
- awareness initiatives (linked with the questionnaires dissemination) that have to be organized regarding the specificities of every partner, building and ESM.

Regard the questionnaires, a different strategy has to be developed for the behaviour questionnaire and the satisfaction one.

### 3.1. AFTER PROJECT: A DIVERSITY OF ENERGY SAVING MEASURES

**Timing:**

Behaviour questionnaires will be disseminated before the optimization implementation or during the first phase of the implementation.

Satisfaction questionnaires can be disseminated two times during the implementation phase : one at the middle of the heating season and one time at the end of the heating season at the end of the experimental phase.

For both the questionnaires, SHOs will take care of organizing some preventive contact with the tenants concerned. Several solutions have been identified to support the communication of the questionnaires towards the tenants:

- cover letter sent with the letter.
- introduction meeting organized with the tenants.
- special partnership with a national or local tenants' representatives association.
- personal and direct diffusion of the questionnaires by SHO' staff, especially in small buildings.

**Length:**

The set-up process for the implementation of the Tenants survey need to be simple, tenant-oriented and will have to allow an efficient analysis focusing on the main useful variables for our testing .The objective is not to have an exhaustive sociological panorama of the tenants habits but to collect useful information regarding what are the main qualitative adjustments that may be necessary to ponderate the results collected.

The basic content of the two questionnaires is enclosed within this document. Nevertheless, both of these structures will be adapted regarding the specificities of every ESM.

**Sample group:**

The sample group will have also to be adapted regarding the specificities of :

- the size of the building (large buildings can have a shorter panel, not all the tenants have to be followed, a representative panel can be identified by the SHO in order to collect more results).
- the organization of the SHO: if some tenants survey has ever conducted before, they can be used within the AFTER process. Some sustain by some tenants association can also be used and have an influence on the identified panel for practical reason.
- the content of the ESM: cf p.11

**Reminder about the role of the M&V Plan as the a logbook for every Tenants Survey :**

All the processes set up to implement the Tenants Survey will have to be adapted within the M&V Plan for every ESM. The questions of the timing, the length and the sample group will be individualized with every document.
The description of the additional questions needed in order to improve the knowledge of the tenants' habits impacting the ESMs will be added in the M&V Plan for every Pilot Sites.
These questions will be developed hand in hand by the SHOs and the WP-leaders according the characteristics of every local situation and topic of interest.

The M&V plan has to be completed by the participating partners as the logbook for the Tenants Survey and will highlight every step, every additional question.
This attention to the M&V Plan as a tool is linked to the very specific characteristic for every implementation situation.

The project envisages the involvement of tenants in pilot sites. Two thousand to three thousand euros are budgeted.
As a consequence, the questionnaires should be completed by a list of actions and initiatives that will be highlighted within the M&V Plans.
A indicative toolbox of possible action is highlighted in the 4th part of this methodology.

For example, with Auvergne Habitat (French Social Housing Organization) has provided the following plan regarding the tenants' involvement:

- a meeting of the collaborative council in February and November for the results of the on-going testing in order to create a first level of information for the tenants : pedagogical technical information will be provided to the collaborative council.
- meetings workshops with a selected panel of tenants to follow the implementation of the ESM on-site and to collect information regarding the uses.
- actions by the local CLCV (French National Tenants Representatives Association) in order to collect the feedback from the tenants, provide some additional information and to promote the result of the testing at a national level.

## 4. LONG-TERM OBJECTIVE: DEVELOPPING STRATEGIES TOWARD TENANTS' AWARENESS

The actions implemented towards tenants can imply different strategies that will impact the kind of survey implemented.

Strategies regarding the tenants' empowerment will depend on choices linked with both the content of the Energy Saving Measure concerned and the general conception of the communication towards the tenants chosen by the SHO.
The information provided to the tenants regarding the energy efficiency for their dwelling and the survey responding to this level of information are connected with some main models that will be developed below.
The level of survey has to be linked with the level of communication implemented by the SHO. A good communication an a good survey will allow to have a complete chain between the information and the supervision of the results linked with this information.

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### 4.1. TENANTS' AWARENESS: MAIN DIRECTIONS AND TOOLS

In order to enhance the quality of the tenants awareness - and not to make it just a wishful thinking -it is necessary to highlight and to structure the range of actions and tools that may be useful to interact with the tenants uses and behaviours.
The enclosed diagram insists on three main axes that will particularly determine the action on the uses.

These three main axis (and their gradation) that will structure our reflection are the following ones:

- the level of generality of the communication/survey towards the tenants : it tackles with the information that will be disseminated, its content, its technical nature and its adaptation to the specificities of the concerned dwelling.
- the level of intensity of the communication/survey : it tackles with the regularity and the closeness of the intervention towards the tenants, the scale and the personalization of the monitoring.
- the level of autonomy of the user : it tackles with the equipment and the systems, the ability and the leeway of the tenant regarding its dwelling, the potential to act on the dwelling.

These axes constitutes the framework of the different types of awareness actions and survey that will be implemented towards the tenants. They both deal with the level of information and of autonomy and comfort of use provided.

Corresponding tools can be placed on the diagram regarding their relationship to these three axis.
These tools can include a variety of levers needful to communicate with the tenants:

- information format co-developed with the tenants.
- guidelines delivered to the tenants.
- website with short movies.
- meetings with the tenants during the refurbishment or the construction of the building.
- energy box delivered to the tenants.
- information meetings, workshops.
- individual monitoring for the energy consumptions.
- comparative analysis between the consumptions in one dwelling.
- home automation.
- awareness visit by external provider.
- personal visit by SHO's staff.
- interventions and lobbying by tenants' association.
- testing workshops before the conception.
etc.

This toolbox can be used regarding the features of the ESM concerned. The corresponding level of survey will be associated by the SHO thanks to the main survey actions highlighted in the first part of the methodology.

### 4.2. TENANTS' AWARENESS: IDENTIFYING SOME RECURRING MODELS

Major models can be identified concerning the strategy developed towards the tenants.
These models will depend on the gradation chosen by the SHOs on the three axis of the diagram and the corresponding tools used to answer to their expectations.

It is possible to highlight some of these main models, even if this list is not exhaustive:

1. Model of the empowerment upstream: well-known strategy which focus on an information adapted (guidelines, book etc.) provided by when the tenant access to its dwelling. Thereafter, the user will have to adopt a virtuous behaviour thanks to this documentation. We work here on the incitement of the best practices but without monitoring regarding their integration.

2. Model of the guided empowerment: Maximalist strategy that implies a constant and focused monitoring. The initial information is completed - on a long term - thanks to a direct care (personal

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interviews, visits, updated information) towards the tenants.

3. Model of global sensibilisation : Widespread strategy oriented toward a general education about the energy stakes without monitoring or a direct adaptation to the dwellings and the tenants. The ambition is to encourage a self-awareness about the sustainable development in order to generate good uses ad practices.

4. Model of the limited empowerment : Strategy based on the prevention and the control of the behaviors. The level of disseminated information is not a priority. We try to act more on the restriction of the bad practices and of the stranglehold of the tenant on its dwelling (maintenance operation carried out by the Social Housing Organization, adjusted equipment, etc.).

5. Model of the maximal empowerment: Strategy based on the disengagement of the SHO on the user topic. The good behaviours are related to the tenants and have to be integrated by them. The best practices are supposed to be based on the good will of the tenant (or its fears regarding the energy bill).

These models are not limiting. They are useful to identify some basis and some main positioning.
The toolbox and its content allows to determine the content of the main families of tenants survey and empowerment that will be implemented during the life cycle of buildings and dwellings.

The objective aims at developing a global framework to identify where we are located regarding the specificities of technical requirements for our ESMs and what is the strategy regarding the scale and the frequency of the information.
The positioning of every ESM and every SHO approach regarding it will allow in order to select some corresponding tools for communication and information.
It will also offer some templates regarding the tenants' survey that have to be implemented in order to fit with this strategy.

As a consequence, the idea of the enclosed diagram is both to identify the level and the type of tenants' awareness chosen (or requested), the investment for the SHO and the corresponding tools.
This diagram can adapted in the M&V Plans for every Pilot ESM and Pilot Site in order to highlight the type of information provided to the tenants. This type of information will also influence the typology of survey implemented adapted. This survey will have to fit with the level of autonomy for the user related to the Pilot ESM and the level of information/communication identified by the SHO.
The satisfaction of the tenants will also be more structured thanks to the positioning on this diagram. The satisfaction regarding the comfort and information can be analysed or at least identified thanks to the positioning of the information delivered on the diagram.

This diagram will be useful for the partners involved in the Tenants Survey for the AFTER project in order to allow the concerned partners to identify their strategies and the level of awareness they want to implement regarding the Pilot ESMs they have to test.

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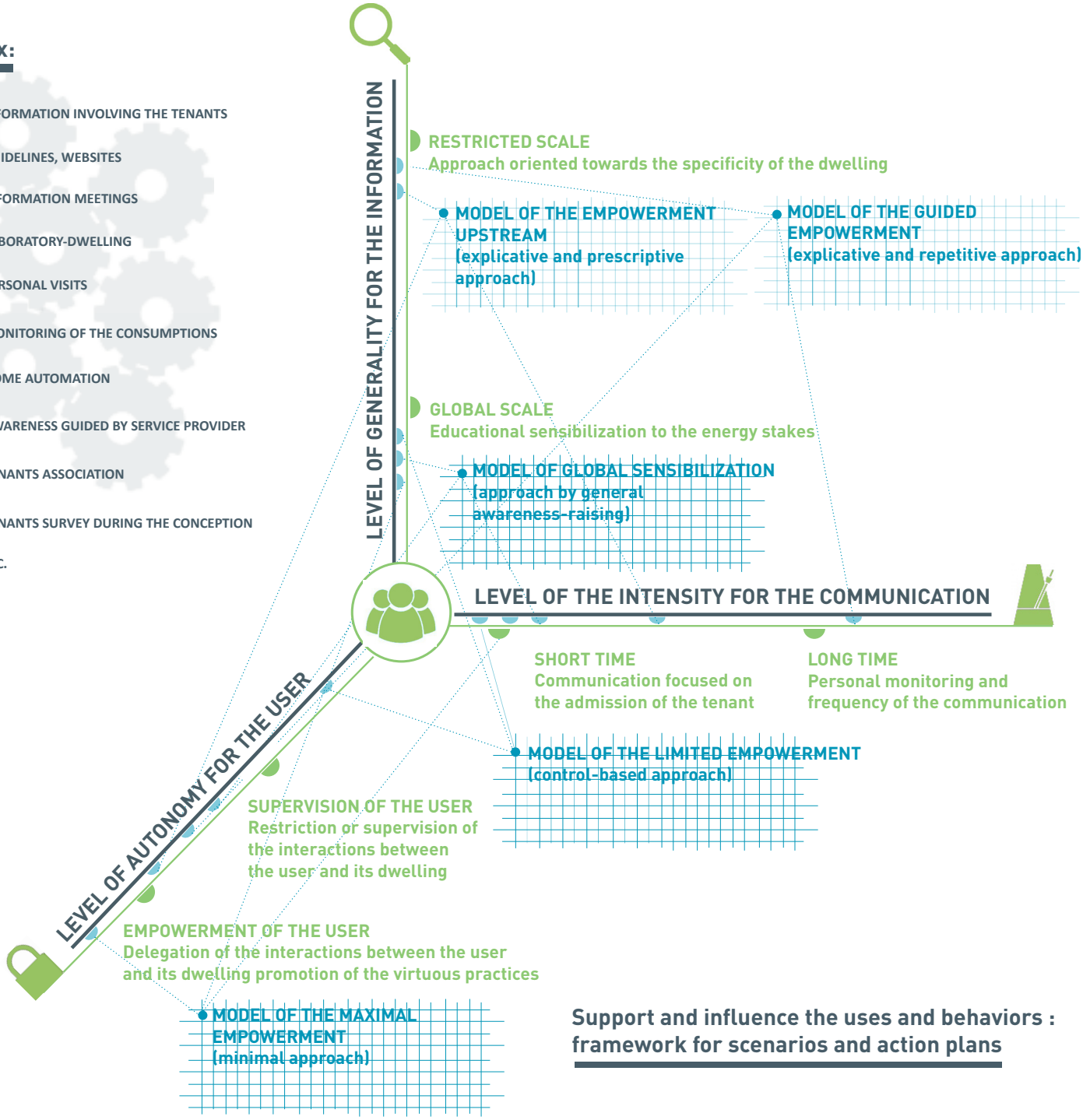
*The tools presented in the toolbox on the left side of the page can be positioned along the three main axis that lead the strategy regarding the uses and behaviors. The distribution of these tools into the diagram propose some main strategic orientations which constitute, according to their positioning, some main models.*

**Toolbox:**

- INFORMATION INVOLVING THE TENANTS
- GUIDELINES, WEBSITES
- INFORMATION MEETINGS
- LABORATORY-DWELLING
- PERSONAL VISITS
- MONITORING OF THE CONSUMPTIONS
- HOME AUTOMATION
- AWARENESS GUIDED BY SERVICE PROVIDER
- TENANTS ASSOCIATION
- TENANTS SURVEY DURING THE CONCEPTION

ETC.




**Support and influence the uses and behaviors : framework for scenarios and action plans**

# TENANTS
## AFTER SCIENTIFIC METHODOLOGY

**Ditsribution of the questionnaires**
**regarding the specificities of the Pilot ESMs and the optimization solutions implemented**

| WPS/PARTNERS | ESMS | SURVEY: BEHAVIOUR | SURVEY: SATISFACTION |
|---|---|---|---|
| **WP3** | | | |
| **Auvergne Habitat (F)** | New energy contract with performance objective and profit-sharing system with the operator containing. | No | Yes |
| **MRA (CZ)** | Remote reading of heating energy and hot and cold water consumption in individual apartments and visualization of consumption data to tenants on internet user web portal | Yes (full BECA) | Yes |
| **BL (DK)** | Tenant information in a passive house, where the Tenants are expected to have an energy-friendly behaviour. | Yes (extended) | Yes |
| **WP4** | | | |
| **MRA (CZ)** | Regulation of pressure in the heating system. | No | Yes |
| **ATC (IT)** | Periodic controls of boiler fume, heating system and exchanger cleaning, pumps and valves control. | No | Yes |
| **SPEKTER (SI)** | Different types of valves and pressure regulators installed on heating system's flow lines, valves on radiators replaced with thermostatic valves, system balanced and regulated with all the new installation. | No | Yes |
| **WP5** | | | |
| **Auvergne Habitat (F)** | How to couple and optimize environmental and economic efficiency in a renewable energy-based heating system (wood). | No | Yes |
| **Bauverein a.g (DE)** | How to adjust and optimize a heating system after the implementation of a new gas calorific boiler but with radiators adapted to the old supply temperature. | No | Yes |
| **ATC (IT)** | How to improve a new heating system (condensing boiler) with specific low-cost interventions on missing insulation. | No | Yes |

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| | | | |
|---|---|---|---|
| **WP6** | | | |
| **Auvergne Habitat (FR)** | Linked with a refurbishment 3 years ago. Replacement of the ventilation system; not a classical Controlled Mechanical Ventilation (CMV) but a Hybrid Ventilation with a control humidity measure to regulate the natural ventilation process. | Yes | Yes |
| **MRA (CZ)** | Global refurbishment of the building (external insulation, exchange of windows, new lifts, light sensors in common spaces). | Yes | Yes |
| **Bauverein a.g (DE)** | Global Refurbishment with ventilation system with heat recovery. | Yes | Yes |
| **ATC (IT)** | In the frame of retrofitting, an Insulated coat of 80mm was applied to an existing building of 1960's. Existing single glazing were substituted with high performance double-glazing. | Yes | Yes |
| **Aarhus Kommune (DK)** | Ventilation: Balanced mechanical ventilation with heat recovery, by-pass function and a heating coil. DANFOSS AIR w2® ventilations unit, with DANFOSS AIR DAIL® wireless control panel. | No | Yes |
| **SPEKTER (SI)** | Recently refurbished building optimized with best practices display in lobby. | No | Yes |
| **WP7** | | | |
| **Bauverein a.g (DE)** | New Construction in Passive House Standard. | Yes | Yes |
| **Aarhus Kommune (DK)** | Pazen Fenster+Technik: Triple glazing, composite profiles. Wood construction: 450-500 mm insulation. Double flow ventilation system. Two dwellings share one system. | Yes | Yes |
| **SPEKTER (SI)** | Recently refurbished building optimized with best practices display in lobby. | Yes | Yes |

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The survey is part of a study about energy consumption in private households and is directed to tenants of [HOUSING PROVIDER].
It deals with your personal opinions and experiences about consuming and saving energy in your home. Your participation helps us see if your awareness reduces energy costs and energy consumption and if it could be improved.
The anonymity of your responses is of course guaranteed. But we would like your name and telephone number, if we have questions to your answers.
Thank you very much for your assistance! Yours, [NAME OF HOUSING PROVIDER]

IDENTIFICATION

Date: .....
.....

Address / name of the building: .....
.....

Number of rooms in the dwelling: .....
.....

Number of people living in the dwelling: .....
....

Occupants identification:
☐ Adults ..... (number)
☐ Children ..... (number)
☐ Employed ..... (number)
☐ Unemployed ..... (number)
☐ Students ..... (number)
☐ Retired ..... (number)
☐ Other ..... (number)

1. Are you in general aware of your energy use ?

☐ I'm very aware
☐ I'm rather aware
☐ I'm neither aware nor not aware
☐ I'm not aware

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If you are not aware, explain why?
.....
.....
.....

2. Data on the appliances in the apartment?

The majority of household appliances:

☐ I don't know the energy classes
☐ Energy class A
☐ Energy class B
☐ Energy class C

Do you use low energy bulps?

☐ Yes
☐ No

Your new technological appliances:

☐ None
☐ Mobile phone
☐ Smartphone
☐ Internet
☐ Timers
☐ Others .....

TENANTS SURVEY - BEHAVIOUR

3. There are different ways people act in their everyday life. Do you agree with the following statements?
In my everyday life...

☐ I open the windows
☐ Less than once a day
☐ Once or twice a day
☐ More than twice a day
☐ When I open the windows, I usually open them widely
☐ When I open the windows, I usually open them partially
☐ I turn off the heating/the radiator when I open the windows.
☐ I turn the heating down when I leave a room unused.

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☐ I turn the heating down when I leave my home for a longer time.
☐ My room temperature at night is usually lower than by day.
☐ I turn out the light when no one is in the room.
☐ In winter time: I mind to keep shut the windows and doors of the commonly used rooms of the tenement
☐ (e.g. basement, staircase, laundry).
☐ I switch off TV or other equipment when there is no one in the room for a longer time.
☐ I completely switch off an appliance with Stand by-function when I have finished using it.
☐ I unplug chargers from the mains (e.g. battery recharchers, charging units).
☐ I mind the energy consumption when I purchase new electric appliances.
☐ I rather take a shower instead of a bath.
☐ I use cold water to wash my hands.
☐ I wait until I have a full load before I use my washing machine or my dishwasher.
☐ I mostly tumble dry my clothes or dry outside the home.
☐ I don't experience condensation or mould in my home
☐ Others .....

4. Is the heat generated by your heating system enough to warm all of your apartment rooms in the winter?

☐ Yes
☐ No

7. What are the usual valve settings in the room?

☐ Closed *
☐ 1 2 3 4
☐ Fully opened 5

5. Which room temperature do you have in much used rooms and in little used or unused rooms in the winter?

Much used rooms:

☐ Less than 19 degrees Celsius
☐ 19-21 degrees Celsius
☐ 22-23 degrees Celsius
☐ More than 23 degrees Celsius
☐ Don't know

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Little used or unused rooms:

☐ Less than 19 degrees Celsius
☐ 19-21 degrees Celsius
☐ 22-23 degrees Celsius
☐ More than 23 degrees Celsius
☐ Don't know

6. Do you consider the room at usual valve setting to be

☐ Underheated
☐ Properly heated
☐ Overheated
☐ Don't know

7. Do you hear noise from the heating system? Describe the noise. When does it happen?

.....
.....
.....

8. Does your home have an air conditioning system?

☐ Yes
☐ No - go to question no. 10

9. How often do you use your air conditioning system in a hot summer?

☐ Less than 1 hour a day
☐ 1-3 hours a day
☐ 4-8 hours a day
☐ More than 8 hours a day
☐ Don't know

# TENANTS
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10. There are different opinions about the need and the possibilities to protect the environment and to save energy. Do you agree with the following statements? (you may write more than one answer)

- ☐ I think I should save more energy at home.
- ☐ My family or friends think that I should save more energy at home.
- ☐ In my opinion protecting the environment is a very important issue.
- ☐ To ensure the decrease of carbon dioxide emissions is important for the protection of the environment.
- ☐ I'm interested in my energy consumption at home.
- ☐ I'm interested in possibilities of saving energy at home.
- ☐ Energy conservation means I have to live less comfortably.
- ☐ Energy conservation will restrict my freedom.
- ☐ Don't know

You have reached the end of the survey - Thanks a lot for participating!
If you have further comments with respect to our survey, please add some keywords:
.....
.....
.....
.....
...

Name: .....
.....
Telephone no. (in case of questions): .....

# TENANTS
## AFTER SCIENTIFIC METHODOLOGY

TENANTS SURVEY - SATISFACTION

IDENTIFICATION

Date: .....
...

Address / name of the building: .....
.

Number of rooms in the dwelling: .....
.

Number of people living in the dwelling: .....

Occupants identification:

- ☐ Adults ..... (number)
- ☐ Children ..... (number)
- ☐ Employed ..... (number)
- ☐ Unemployed ..... (number)
- ☐ Students ..... (number)
- ☐ Retired ..... (number)

GENERAL SATISFACTION

1. Are you generally satisfied with the establishment of «name of ESM" ?

- ☐ I'm very satisfied
- ☐ I'm rather satisfied
- ☐ I'm neither satisfier nor dissatisfied
- ☐ I'm very dissatisfied

2. If you are dissatisfied, explain why?
.....
.....

3. Do you think the establishment of «name of ESM» allowed you to achieve energy savings ?

- ☐ Yes
- ☐ No

# TENANTS
## AFTER SCIENTIFIC METHODOLOGY

4. Did you measure your energy consumption before the establishment of «name of ESM»

☐ Yes
☐ No

If yes - how did you measure it (invoice, short interval consumption information, ICT / smart meters, other means) ?
.....
.....

SATISFACTION WITH COMFORT

| | | | | |
|---|---|---|---|---|
| | | | | |
| 5.1 | Do you use it? Is it helpful? Have you won in thermal comfort (your home is heated more easily) ? (To be developed within the WPs - cf M&V Plans) | | | |
| | | | | |
| | | | | |
| | | | | |

6. In your opinion, does the establishment of « name of ESM « entails some disadvantages or constraints ?

☐ Yes
☐ No

If yes which ones?
.....
.....
.....

SATISFACTION WITH ECONOMY

7. Following the establishment of «name of ESM» : (personalize according the type of measure)

# TENANTS
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| | | | | |
|---|---|---|---|---|
| | | | | |
| 7.1 | Has your rent / receipt increased due to this work ? | | | |
| 7.2 | Have you saved money on your rent/ your energy bill ? | | | |
| | | | | |
| | | | | |
| | | | | |

SATISFACTION WITH INFORMATION

8. Do you think you have been sufficiently informed about the implementation of «name of ESM» ?

☐ Yes
☐ No

9. At what point in time have you been informed ?

| | Yes | No |
|---|---|---|
| Before the implementation | | |
| During the implementation | | |
| After the implementation | | |

10. Was this information sufficient?

☐ Yes
☐ No

11. If not, specify the information you would have liked to receive ?

.....
.....

12. Dialogue

| | Yes | No |
|---|---|---|
| Did a dialogue take plane about «name of ESM»? | | |
| Have you been consulted ? | | |
| Has your opinion been taken into account by your housing provider ? | | |

# TENANTS
## AFTER SCIENTIFIC METHODOLOGY

You have reached the end of the survey - Thanks a lot for participating!
If you have further comments with respect to our survey, please add some keywords:

.....
.....
.....
.....
.....
.....

Name: .....


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