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

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FOREWORD

BY **JULIEN BONNET,** PROJECT MANAGER, DELPHIS, PARIS, FRANCE

The post-investment phase is a major challenge for energy savings, as it still contains unexplored potentials. Due to the economic context and the growing complexity of the new systems and design, social housing need to be concentrated on pragmatic solutions and knowledge in order to reach ambitious European objectives concerning energy.

The team behind the AFTER project, which is being presented in this magazine, has been looking for energy solutions to be implemented «after» the design and construction phases. The challenge has been finding adjustments and corrections to bring the building up to its constructed energy and economic performance and then to optimize it.

AFTER is covering a large range of actions related to the energy performance. This includes technical interventions on heating, ventilation or domestic hot water systems, but also measures related to the contracts and tenants awareness. Managing and highlighting this variety of approaches is one key issue for the project.

18 Pilot Sites have been involved in the project including more than 1000 dwellings in 6 different countries. 3 to 7% of additional savings have been achieved concerning these Pilot Sites. These savings are related to already implemented investments such as global refurbishments, replacement of boilers or construction of low- energy buildings.
The interesting results are concerning interventions such as intelligent monitoring solutions for heating, hybrid ventilation, balancing of oversized heating systems, control of the domestic hot water consumptions in low energy buildings or tenants campaigns.

Efficient impacts have been achieved with limited investments. All the results will impact the future routines of our participating Social Housing Organizations and can be used as recommendations and a toolbox for other European Social Housing Companies. The project website, **www.afterproject.eu** in seven different languages, supply this magazine, and all the detailed information on the project can be found here.

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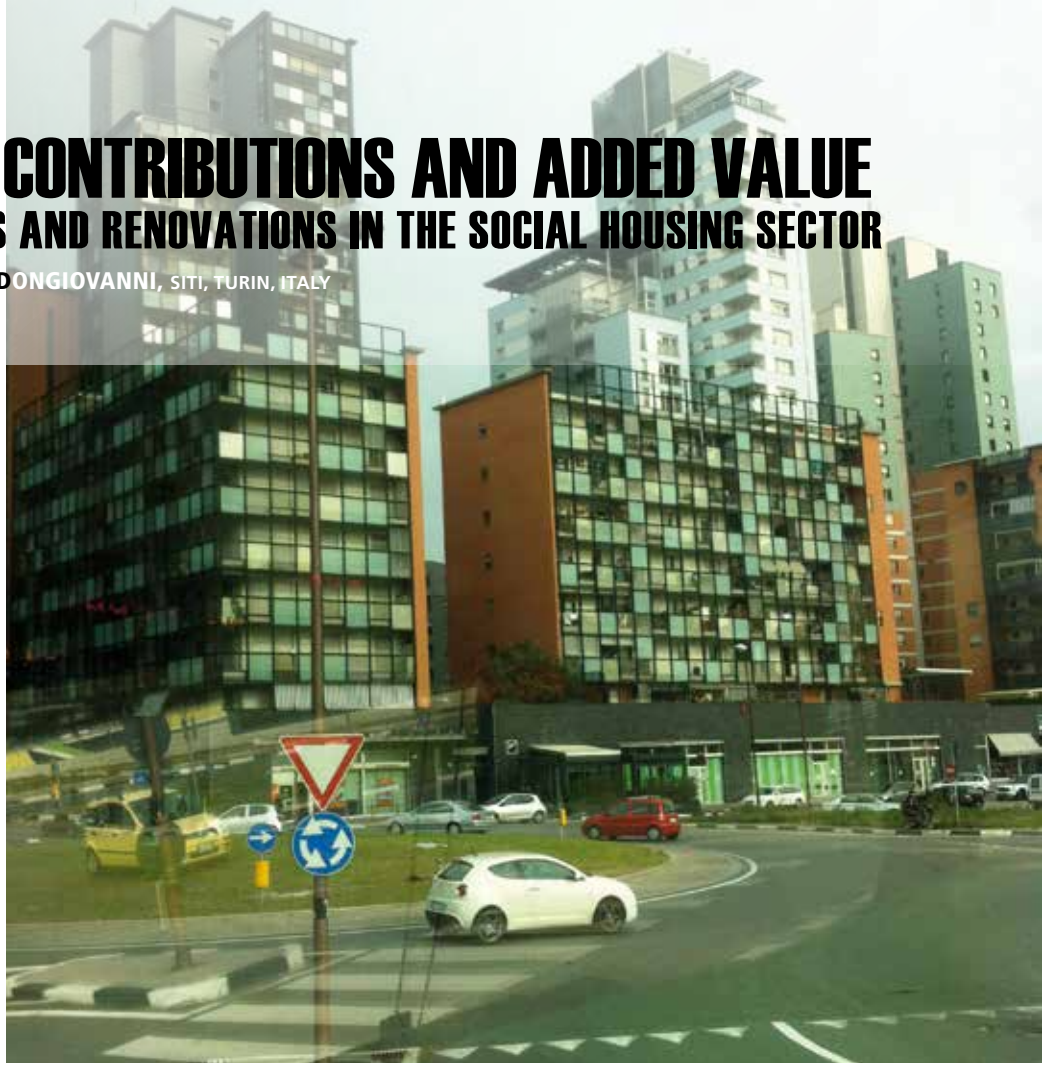
ENERGY SAVING CONTRIBUTIONS AND ADDED VALUE
TO LOW ENERGY BUILDINGS AND RENOVATIONS IN THE SOCIAL HOUSING SECTOR

BY **ELISABETTA CIMNAGHI** AND **ARIANNA DONGIOVANNI**, SITI, TURIN, ITALY



If it is true that the purpose of Social Housing Organizations in Europe is to offer quality accommodations at prices commensurate with their income to people with economic problems. It is equally true that today a housing policy is not satisfactory if – among other things – it does not contribute to energy saving, taking the rising energy prices into consideration. This fact becomes more significant when you consider the current period of crisis in which the governments -some more than others- have to deal with the financial difficulties of households and more and more reduced ability to stimulate public spending because of the austerity measures

The building sector has been identified as one of the biggest energy consuming sectors (40% of the total EU energy consumption). In Europe more than 25 million buildings belong to the social housing stock – approximately 12% of the total stock, according to data from the European Social Housing Organisation, CECODHAS - Housing Europe.

The construction of new dwellings has decreased since the crisis. On average new buildings represent only 1% per year, of the existing stock. The ratio of major renovations to overall housing stock is very low. Current refurbishment rate stands at 1.19% each year, with an average investment of €32,250 per dwelling, (totally around €10.4 billion each year).

If the sector is to meet 2020 targets and achieve a 20% energy demand reduction in line with European policy objectives, a great funding gap must be addressed. In order to attain this figure using current best practices, an additional total investment of €180.6 billion will be needed for the period 2014-2020[1]. The need to improve the performances of the investment done in this refurbishment is very obvious.

The need for new solutions to lower energy consumption has to meet the difficulties of the social housing sector and particularly the public sector, to make investments due to financial shortages. At the same time, the need of reducing energy bills for the tenants is more and more urgent. There are two solutions available: the "hard" solution (retrofitting and restructuring according to the principles of sustainable development) and the "soft" solution: (raising of the tenants' awareness to get them to change their energy behaviour). In any case, the evaluation of the performance of a building cannot be only technical; it has to take into account the social impact (evaluation of the well beings of the tenants, the way an innovation is accepted by the tenants...)

In the last years, Social Housing Organizations[2] have played an exemplary role in improving the energy efficiency of the housing

sector. They have anticipated forthcoming national legislation and have experimented new energy saving measures, e.g. with the construction of low-energy buildings and innovative energy refurbishment. For instance in France, on average, the social housing sector uses 20 % less heating and hot water than the average existing housing stock[3].

The project AFTER – Cost Optimum and Standard Solutions for Maintenance and Management of the Social Housing Stock – has produced methodologies and tools for the social housing operators in order to help to promote and continue this effort, especially in the light of the obstacles and challenges presented by the current economic situation. Its goal was to enforce the role of Social Housing Organisations in the field of energy efficiency by experimenting costs effective solutions (not more than 400€/ dwelling) and promoting them to the entire European building sector.

Italy provides a striking example for the relevance of the project. Italian Social Housing public Organisations have a total asset of approximately 820.000 dwellings. It has been estimated by Federcasa (Italian union for social housing organisations) that at least half of them needs to be refurbished, since they were built around 30 years ago – when the energy performance of buildings was not a priority. These 400.000 units are without insulation, with single-glazed windows and their equipment is often obsolete. Besides, the national economic resources are scarce. For these reasons, the identification of low-cost solutions for energy efficiency is a high priority.

AFTER

Social Housing Organizations in 6 different countries (Czech Republic, Denmark, France, Germany, Italy, and Slovenia) and their partners – including National Housing Associations, Scientific Committee and National Tenants Associations- have cooperated for three years to highlight and evaluate the most efficient and adaptable energy saving measures.

The partners participating in the project have demonstrated that the proper management and maintenance of residential buildings, based on shared protocols and methodologies, may contribute to the substantial reduction of energy consumption, bringing economic and environmental benefits which translate into social benefits. The measures experimented during the project reduce energy consumption, not the comfort of the tenants.

The methodologies and outcomes of the project, are able to meet different national needs and expectations, approaching the theme of energy saving from different points of view: technological optimization via more efficient regulation of ventilation and heating systems, negotiation with suppliers, smart metering, use of thermography before and after refurbishment etc., and, most important, measures focused on the tenants' energy behaviour and awareness improvement.

The AFTER project showed that the research of economic, social and environmental efficiency has to become a constant concern of the housing organisations from now on. The optimization of existing buildings performances will become an issue as important as the technical innovations in new buildings, because the social housing sector cannot afford a building that does not function in a fully optimal manner.

This is a major change in the way Social Housing Operators manage their existing stock. They have to learn how to monitor, evaluate and, if necessary, correct imperfections in the building's day-to-day management. The AFTER project is an important step in the creation of tools, routines, to help Social Housing Operators implementing this culture of constant evaluation of the building.

Let's hope that these tools will be replicated to all Europe, helping to under pass the gap between the CO^2 reduction goal 2020 and the diminution of resources.

1) Data by Beem up project: Energy refurbishment for sustainable SPC housing, Insights on the current market and trends towards 2020, March 2014. Cecodhas Housing Europe, Bax & Willems Consulting Venturing

2) For Social housing we adopt the definition proposed by the European Commission in the Decision of 20 December 2011 "provision of social housing for disadvantaged citizens or socially less advantaged groups, who due to solvency constraints are unable to obtain housing at market conditions" (OJ EU L07/2012)

3) Stats from l'Union Sociale pour l'Habitat (FR)

TOP 10 ENERGY SAVINGS IN THE AFTER PROJECT

BY **JULIEN BONNET,** PROJECT MANAGER,
DELPHIS, PARIS, FRANCE

A very big but not totally unexpected surprise in the project was that in new low energy buildings it is possible to achieve a large energy saving by optimizing the performance after the building has been finished. This is also according to other studies – e.g. in USA and Sweden – showing that performance documentation after finishing a building or a retrofitting is of the greatest importance to verify the energy quality of the building

As an important part of the AFTER project, a testing of 18 pilot sites has been implemented. Six social housing organizations from six countries (Denmark, Germany, France, Italy, Slovenia and Czech Republic) have each selected and assessed three energy saving measures, on the basis of a data collection and an analyzing. The potentially best measures concerning energy efficiency, economy and social behavior have been pointed optimized, measured and evaluated.

BEST INTERVENTIONS

Overlooking the results from the 18 pilot sites, the Top Five of intervention are as follows:

- **No 1**: Optimizing New Low-Energy Building – savings of up to 21 %
- **No 2:** Optimizing Operating Management of the Building Stock - savings of up to 11,7 %
- **No 3:** Optimizing Running Maintenance of the Systems - savings of up to 6,5 %
- **No 4:** Optimizing Recently Refurbishment Buildings - savings up to 5 %
- **No 5:** Optimizing System Replacement - savings up to 4 %.

The expected result of the optimum standards or scenarios was between 2,5 and 7 %, which means that the project has met the expectations.

TOP 10 OF THE BEST SAVINGS IN THE PROJECT

It has shown during the testing that finding the data for the baseline, and having data loggers and meters for measuring during a period, which gives data enough for a scientific comparison, is not he easiest. This has led to the result that - although there have been good experiences and facts in all the pilot sites - not all data (and pilot sites) are comparable. From the overview of the 18 pilot sites, we can deduct the following "Top 10" of savings within the five different types of interventions mentioned above:

NO 1: SC9B – SLOVENIA

Type of intervention: Over dimensioned heating system in new low energy building.
Initial Energy Saving Measure: Recent low-energy building with 10cm EPS shell insulation, windows with double-glazing and natural ventilation. Building is connected to district heating network through a heating substation. Inside the apartments, temperature is regulated with thermostatic radiator valves.
Additional AFTER Optimization: According to assessment from energy expert, the heating system is over dimensioned by factor 4, a tuning of the heating curves and a conversion to low temperature heating in the system is implemented reducing heating power of radiators to 1/3.
KEY FIGURE: Compared to the 3-year average value of the baseline period, the figures lead to a consumption of 9 MWh/a or 12.2 kWh/(m²a) during the period after the optimization, which equals a reduction of 21 %.

NO 1: SC9B – SLOVENIA

NO 2: WOHNART – GERMANY

NO 2: WOHNART3 – GERMANY

Type of intervention: Closing circulation pump at night in new PassivHaus.

Initial Energy Saving Measure: Passive house building including an external thermal insulation of the facade with 30 cm EPS, double-flow ventilation system, windows with triple heat protection glazing and electric warm water tank.

Additional AFTER Optimization: Improvement of the energy consumptions for the domestic hot water system adjusting running time of the circulation pumps at night. A collective discussion with the tenants of the building has been implemented in order to implement this measure without damaging their general comfort.

KEY FIGURE: Passivhaus-certified building with a final energy performance: 43 kWh/m^2/year. The energy consumption deduced from the meter readings lead to approx. 18 to 20 % lower values: the DHW consumption in 2011 and 2012 was calculated to 19.1 and 19.2 kWh/(m^{2}a) resp. 216.8 and 217.4 kWh/d.

NO 3: JABURKOVE – CZECH REPUBLIC

Type of intervention: Improving a web tool for energy information toward tenants.

Initial Energy Saving Measure: Web portal and smart metering system implemented to increase the awareness of the tenants regarding their domestic hot/cold water and heating energy consumptions.

Additional AFTER Optimization: Improvement of the functionality for the web portal and empowerment process for the tenants including: new introduction webpage, complementary distribution of hard copy for the consumptions reviews, benchmarking actions and complementary personal advising.

KEY FIGURE: Consumptions for heating and Domestic Hot Water after optimization = - 11,7% after the implementation of the Internet service and the optimization solution.

NO 3: JABURKOVE – CZECH REPUBLIC

NO 4: RIESI – ITALY

NO 4: RIESI – ITALY

Type of intervention: Change of boiler and additional smart metering system

Initial Energy Saving Measure: In 2009-2010, a new heating system including three condensing boilers has been implemented, replacing an obsolete boiler with high-energy consumptions.

Additional AFTER Optimization: Implementation of a smart metering system with an automatic maintenance and regulation of the new heating system (regulation of the temperature settings and calibration of the heating curves).

KEY FIGURE: The implementation of the smart metering system has led to normalized savings corresponding to approx. 6,5% of the existing consumptions for heating.

NO 5: TOLSTEHO – CZECH REPUBLIC

Type of intervention: Thermography implemented after a global refurbishment and complementary punctual corrections on the shell.

Initial Energy Saving Measure: Refurbishment including: external thermal insulation from no insulation to 140 mm of EPS, roof insulation, windows replacement from wood simple-glazing to PVC carpentries with double-glazing.

Additional AFTER Optimization: Thermography and corrective actions implemented around the windows frames, where thermal deficiencies have been identified.

KEY FIGURE: The average reduction of the normalized energy consumption after the refurbishment attests savings around 32%. The optimization reduces heat loss of the windows by infiltration by about 10% which brings savings of heating energy in range of 3-5%.

NO 5: TOLSTEHO – CZECH REPUBLIC

NO 6: HEINHEIMER – GERMANY

NO 6: HEINHEIMER – GERMANY

Type of intervention: Hydraulic balancing after the Replacement of a heating system.

Initial Energy Saving Measure: Replacement of a central standard boiler from 1982 with a new natural gas central heating system including 3 gas calorific boilers working with a lower flow temperature.

Additional AFTER Optimization: Hydraulic balancing of heating pipeline through installation of modern thermostatic valves and adjustment of the volume flow and pump speed in order to ensure that each radiator will get the same amount of heat. Revision of the control technology of the heating system in order to achieve a longer running time for the burner.

KEY FIGURE: The hydraulic balancing led to average energy savings about 4 % regarding the expected range.

NO 7: PASSONI – ITALY

Type of intervention: Replacement of a heating system and additional intervention on its insulation.

Initial Energy Saving Measure: Substitution of two old twin boilers with one new condensing boiler using natural gas.

Additional AFTER Optimization: Implementation of an additional insulation cap on the heat exchanger of the condensing boiler. Additional monitoring of the temperatures in several dwellings is implemented.

KEY FIGURE: The replacement of the boiler resulted in energy savings of approx. 26%. The optimization has improved the existing performance for the boiler by 3,84 % regarding the baseline period.

NO 7: PASSONI – ITALY

NO 9: RAMEAUX – FRANCE

NO 8: UZAVRENA – CZECH REPUBLIC

Type of intervention: Hydraulic balancing of the heating system

Initial Energy Saving Measure: Regulation of flow and pressure of the heating system in the building.

Additional AFTER Optimization: Control of the balanced heating system scheme and technical inspection during the operating period including a recalculation of the heating curve and adjustment of the temperature gradient.

KEY FIGURE: The hydraulic balancing of the heating system was done only partly. The heating system has already been controlled before the adoption of the optimization measure through TRVs. The corresponding optimization has allowed savings of 1,6% (including the fact that the heating season 2013/2014 was extremely warm)

NO 9: RAMEAUX – FRANCE

Type of intervention: Energy contract review.

Initial Energy Saving Measure: Review of an existing energy supply and maintenance contract. The new version of the contract includes a profit-sharing system between the Social Housing Organization and the energy provider based on performance objectives regarding energy consumptions.

Additional AFTER Optimization: Identification of the energy savings obtained thanks to the regular follow-up of the maintenance interventions made by the energy supplier.

KEY FIGURE: Consumptions for heating and Domestic Hot Water after optimization = - 1% regarding the contractual objective (591 MWh). Before optimization the actual consumption was +4,5% regarding the contractual objective.

NO 10: MAARSLET – DENMARK

Type of intervention: New low-energy housing for seniors.

Initial Energy Saving Measure: Highly insulated building (roof: 445mm, walls Insulation: 330mm EPS). Windows with triple-glazing and aluminium frames. Solar panels on the roof. Balanced mechanical ventilation with heat recovery and by-pass function. Under-floor heating directly connected to district heating supply.

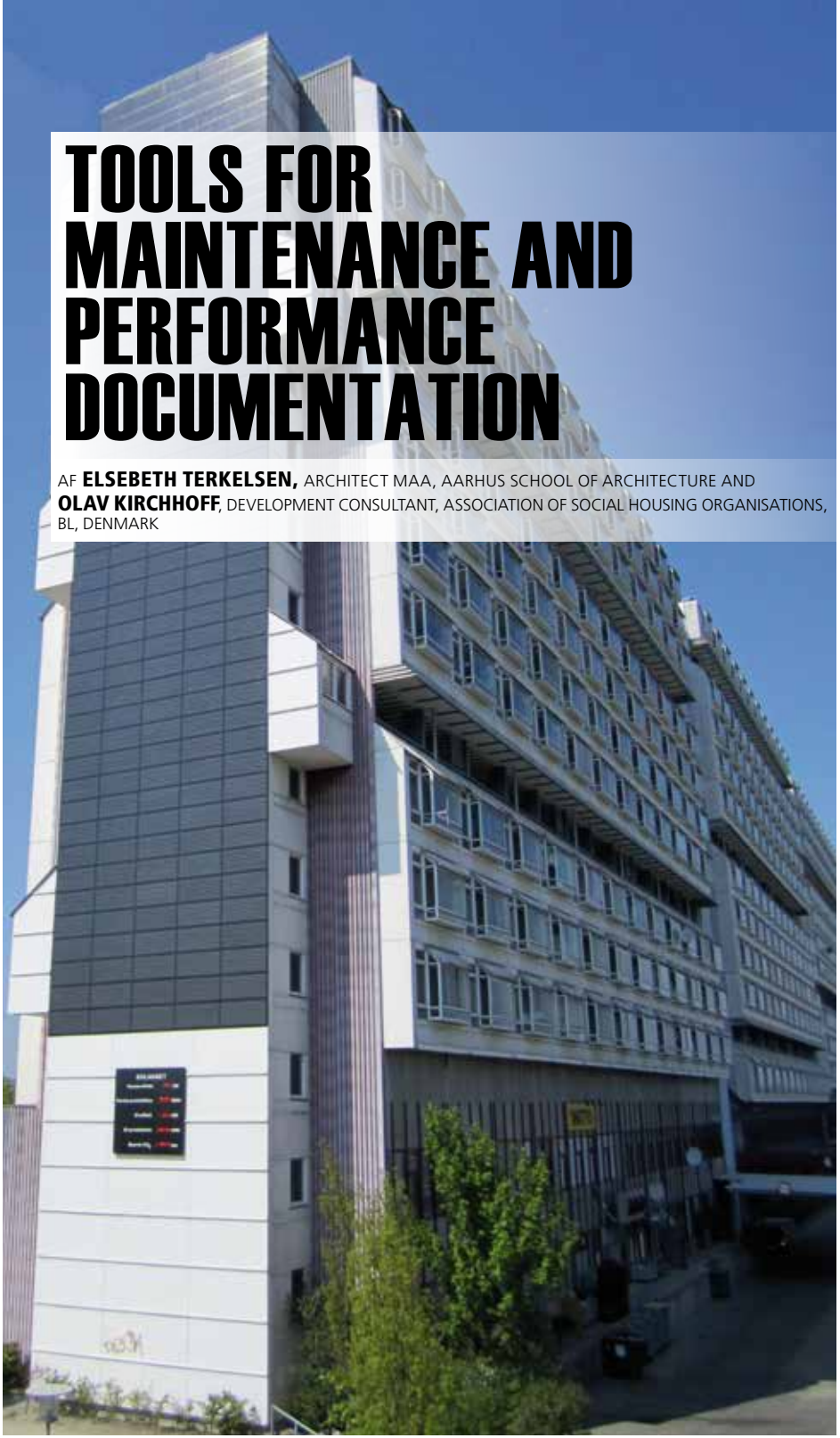
Additional AFTER Optimization: Domestic hot water is supplied directly by district heating network thanks to a heat exchanger (no tank). `The control valve for hot water was adjusted for comfort causing the heat exchanger running idle for fast production. The set-up has been readjusted for heat savings preventing idle. Tenants will have to accept slightly longer waiting time for hot water.

KEY FIGURE: Low-energy building with a final energy performance: 43 kWh/m²/year. The energy consumption deduced from the meter readings lead to approx. 18 to 20 % lower values: the DHW consumption in 2011 and 2012 was calculated to 19.1 and 19.2 kWh/(m²a) resp. 216.8 and 217.4 kWh/d.

NO 10: MAARSLET – DENMARK

TOOLS FOR MAINTENANCE AND PERFORMANCE DOCUMENTATION

AF **ELSEBETH TERKELSEN,** ARCHITECT MAA, AARHUS SCHOOL OF ARCHITECTURE AND **OLAV KIRCHHOFF**, DEVELOPMENT CONSULTANT, ASSOCIATION OF SOCIAL HOUSING ORGANISATIONS, BL, DENMARK



The life of a building AFTER it is designed needs to be an important focus area in the design process. But it is often forgotten. Architects and designers need to be addressed and made aware of their responsibility of including design of technical installations, accessibility of the technical installations, position of meters etc. in retrofitting and new building projects. Designers and architects should become much more aware and acquainted with the technologies for operation and maintenance of buildings in order to develop retrofitting and low energy buildings in our future society. The social housing organisations and the building owners should at the same time be better at demanding design of the management and operation of the buildings – new build or retrofitting

THE AFTER PROJECT

To reach the 2020 goals of energy saving, the building design and the building performance are to be optimized. AFTER focus on the synergy between the two elements and the extra gains that can be achieved. From a scientific point of view it is very interesting to develop methods and tools to reveal the operational problems and problems with operation and maintenance – to improve the energy performance of the building. In other words: Listen to the buildings! In the AFTER project we have an extraordinary opportunity to analyse, optimize and test, how the buildings can function better. At the same time this knowledge can give a basis for improving the design of the technical parts of the buildings in the future.

INSPIRATION FROM USA

The project has inspiration from USA concerning two central elements in the methodological framework of the project:

- Retro-Commissioning and
- Evaluation, Verification and Measurement concepts.

The 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". See also article on *Successful retro-commissioning process in Lystrup*.

The methods for evaluating, measuring and verifying the pilot sites in the project are also developed on behalf of American experiences. AFTER uses the IPMVP (International Performance and Measurement Verification Protocol) as common basis to elaborate its own testing protocol. 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 (Energy Saving Companies).

NEW TOOLS

In the AFTER project we have developed a methodological framework and tested a set of "tools" to identify problems, possible improvements and optimizations concerning management and operation of new low energy and energy renovated buildings.

The methodological framework of the project has been developed in cooperation between the scientific partners and the social housing organisations, associations, and the tenants' organisations in the project.

As a result, the AFTER project has created a number of tools, which can help social housing organisations or private house owners to optimize their buildings' performance.

HANDBOOK

When working with performance documentation it is extremely important to develop a set of definitions to be able to describe and compare the results.

The Handbook is a common platform with definitions. The Handbook gives the specification of the perimeter, metering units, nature and specific remarks to help the common understanding.

A big, but also well-known challenge has been to calculate the square meters as the basis for finding the right and comparable data for the energy consumption and the economy of the energy savings. The way we calculate areas in the different European countries is very different. But the Handbook gives an overview of the different calculation methods and points out the one to use to compare energy saving and economic results in the context.

An important element has also been the definition of baseline and metering period, and the Heating Degree Days. This is being described in the article *Data collection and interpretation of results* in this magazine.

The Handbook is available in seven languages on www.afterproject.eu.

FACT SHEETS

In 84 fact sheets we are describing all the energy saving measures that have been listed in the AFTER project. The fact sheets can be defined as a "catalogue of good ideas" for optimizing the buildings' energy performance.

The social housing organisations and scientific experts have developed the fact sheets in cooperation. The focus is not only on the technical or managing issues, but also the experiences and tips for others, interested in implementing the energy saving measures.

RETRO-COMMISSIONING

An important, new element in the operation and management of social housing might be the Retro-Commisioning. It can be described as a building check in twelve steps and is the background for preparing a Master List of Deficiencies and suggestions for energy saving measures, improvements and optimizations.

The Retro-Commisioning (RCx) focuses on offices and industry buildings. In the AFTER project, we focus on the social housing sector, and the conditions in this sector. The results show that important elements in RCx and in revealing the problems in the buildings are

- Registration of the energy use – big variations over the year(s) show, if action is needed. It might be technical and / or dependant on tenants' behaviour or awareness
- Registration of tenants' complaints can indicate that there are some technical problems in the building that need to be solved
- Interview with the caretaker might reveal bigger problems in the building
- A structured method with questions and documentation – like the RCx – helps the process.

An example of a RCx process is described in the article *Successful retro-commissioning process in Lystrup*. In Lystrup the interview with the tenants and the caretaker revealed some construction failures, resulting in problems with the indoor climate, the temperature in the rooms and the comfort for the tenants. Fortunately the failure was discovered before the end of the guarantee and could be improved without costs for the owner.

A closer description of the twelve steps

and the RCx process is integrated in the description of the methodology and can be found on the website of AFTER.

COMMON EVALUATION PROTOCOL OR "M&V PLAN"

A very important element in AFTER is the performance documentation. The Common Evaluation Protocol, or – as it came to be called in the project – the M&V Plan, describes the process to collect the different data necessary to evaluate the energy performance, the economical performance and the social performance, the necessary indicators, how to measure, by what means (meters), baseline and reporting periods.

The M&V Plan consists of all the practical information for measurement & verification of an energy saving measure. It follows the general structure of the IPMVP (International Performance and Measurement Verification Protocol), simplifying some of its aspects. It's main objective is to illustrate a process of assessment that can be adapted to every type of intervention in the housing stock.

CONCLUSION

The most important conclusion from developing and testing the tools in the AFTER project has been experiencing the importance and necessity of checking the building performance after finishing the new low energy building or the retrofitting. It was of course the thesis of the AFTER project that we could expect findings to improve the energy performance. But the lack of tools and formalized processes to measure and verify the performance was surprising. We generally had a big challenge in finding data.

The use of the tools has also revealed the importance of focussing on the design of the technical installations. Designers and architects should become much more aware and acquainted with the technologies for operation and maintenance of buildings to make it easier to see and control the installations for heating, water, ventilation etc. Dataloggers could be an integrated part of the building – strategically located e.g. to measure the use of hot and cold water, both for the information of the tenants, living there, and for the social housing company.

The social housing organisations and the building owners should at the same time be much better at demanding design of the management and operation of the buildings – new build and retrofitting.

Finally the surprises in construction and dimensioning of installations, lacking of setup of automatics, dysfunctional parts that were not known earlier, and – very important – the very few cases, where the measurement and verification of the operation and maintenance of the building was included in the management and operation of the buildings, calls for much more "AFTER".

SUCCESSFUL RETRO-COMMISSIONING PROCESS IN LYSTRUP

BY **FRANK KEJLBERG,** CONSTRUCTING ARCHITECT, MUNICIPALITY OF AARHUS, DENMARK AND
ELSEBETH TERKELSEN, ARCHITECT MAA, AARHUS SCHOOL OF ARCHITECTURE, DENMARK

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 methodologies have been particularly developed within the American procedures to improve the energy performance in large office and production buildings, especially regarding facilities. Thereof, the main existing retro-commissioning literature focuses on office and production buildings.

As a consequence, the AFTER project has focussed on conserving the essential objectives of the Retro-commissioning (improving the energy performance) in the social housing sector. Procedure has been kept as simple as possible, focusing on objectives and adjustments according to the social housing organisations' needs.

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".

LYSTRUP

LYSTRUP in Denmark has been refurbished in 2011. The original building was constructed in 1984 and had a quite large energy-consumption; approximately 150kWh/m^2 for room heating per year; as well as low comfort, most significant problem was not being able to sustain adequate room temperature in the coldest months.

The flat fronted wave heat radiators were probably a bit under dimensioned from the beginning and as the inlet temperature of the district heating has decreased since the construction in 1984, due to energy saving measures performed by the supplier on the general distribution system and the local production of district heating, the issue increased over the years.

On the external shell there were many thermal bridges along the foundation and the window frames.

These two issues combined with the mix of natural and simple mechanical ventilation in the bathroom not being able to keep up with the contamination/moist from bathing and cooking, often resulted in poor quality of the indoor climate.

Bathrooms were also below recent standards regarding assisted living technology and were not equipped properly for elderly/disabled tenants.

However the need for this kind of dwellings in the local community, 10 km from Aarhus city, was obvious. The architectural impression and the quality of the brick building were considered worthy to preserve, so it was decided to refurbish the dwellings.

The objective of the retro-commissioning process (RCx) was to identify some weak points in the energy consumption of the building in order to improve its post-refurbishment performance.

An interview with the caretaker and the tenants, all elderly people, revealed a problem with cold air and draft from the new ventilation system.

The Aarhus Municipality staff made an examination, a RCx of the building and it's HWAC installations (ventilation systems). The team found that in the refurbishment project, the under-floor heating and heat recovery ventilation system had been made partially inter-dependent.

The water-borne heating surface in the ventilation system was connected to the mixing circuit for the low-temperature under-floor heating. So hot water could only flow to the heating surface and preheat the inlet air, if the under-floor heating was on. Even in this case the situation was not good as the low temperature of the pre-mixed water for the under floor heating could not supply the heating coil with enough energy.

In order to optimize the system, Aarhus Municipality staff proposed to separate the supply for the heating coil from the low-temperature mixing circuit of the under-floor heating.

Supplying "high temperature" district heating directly to the heating coil through an already existing control valve, controlled by the automatic in the ventilation system measuring inlet air temperature, enabled the heating coil to function properly.

The separation has lowered the discomfort from cold (not properly preheated) air being blown in. Some tenants still experience problems with draft even though the inlet air is now preheated 5-6 degrees above room temperature. Systems are now functioning correct after the optimization. Anyway there are still draft problems to some degree. We will probably address this trying to raise the inlet air temperature even further.

LESSONS LEARNED FROM THE RCX PROCESS IN LYSTRUP

A valuable lesson is that ventilation by displacement should be chosen with great care in buildings for housing, because the principle itself imposes problems with draft. It's especially important in housing for elderly/disabled people with low physical activity level and the need for high in-door room temperatures.

As a follow up towards the tenants, it is agreed that the tenants can get personal assistance from the caretaker to set individually desired room temperatures. In this process it will be interesting to see if the "on-period" of the under-floor heating is shortened in the coming heating seasons.

If systems (like heating) are run automatically, the programming must be in focus. Tenants' requests regarding in-door climate and general comfort should be listened to very attentively.

Tenants need assistance in operating the automatically controlled heating and ventilation system, i.e. help them to set and program the automatics. It has to be integrated in the workflow to alter settings occasionally. The close observation of what is usually the « tenants controls » also shows errors in construction, dysfunctional parts etc. and helps to identify those with the opportunity to make use of warranties.

When communicating with elderly tenants the focus should be on the personal contact via well known staff (like the caretaker); If

Retro-commissioning (RCx) as developed in the AFTER project can be described as follows:

A SYSTEMATIC PROCESS FOR IMPROVING AN EXISTING BUILDING'S PERFORMANCE
In the AFTER Project, RCx has been developed to be very directed to the equipment and systems of a building that could enhance its global performance. It is very pragmatic and inspired by existing routines, implemented by Social Housing Organisations (SHO) to optimize their energy consumptions.

IDENTIFYING AND IMPLEMENTING LOW-COST OPERATIONAL AND MAINTENANCE IMPROVEMENTS
The RCx links diagnosis and proposals for improvements of a building's performance. RCx focus mainly on "low-cost" operational and maintenance improvements.

ENSURING THAT THE BUILDING'S PERFORMANCE MEETS OWNER EXPECTATIONS
As we focus on housing and most particularly on social housing, the concept of "owner expectations" has to be widened and has to integrate the tenants. But it includes the SHOs obligations to secure the energy efficiency of their building stock.

Result of the RCx process
The positive effect is e.g. to be able to:

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

When to do it ?

- an unjustified, high energy-use index is registered
- 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.

their opinion is needed, prefer face-to-face interviews instead of written questionnaires and surveys. If contact is established, be prepared to deal with items, which are not on the agenda, but deal with all sorts of daily life issues in these dwellings. The tenants use the chance to discuss these issues, too.

Elderly tenants often prioritize comfort over energy savings – in general the tenants involved perceived energy savings as a lowering of their comfort.

SAVINGS

In terms of financial performance this optimization was free of costs, as the division of the two heating systems, the under-floor and the heating coil in ventilation, was done within the complaint period by the original contractors.

We can say that after the regulation of the heating and ventilation system, the building reaches a moderate, normalized energy consumption: from 80 up to 106 kWh/m^2/year. This trend should help the SHO to save money and to reduce its carbon leakage.

RECOMMENDATIONS

Manufacturers of control panels for HWAC need to be aware of tenants' needs to control the systems. User friendliness and intuitive use are the keywords. Also we see the need for a simple common system that can integrate all HWAC-installation controls within each apartment.

The RCx-process performed in the framework of AFTER revealed many surprises in form of lacking setup of automatics, dysfunctional parts that were not known earlier at the usual transfer to operation. Therefore, commissioning in an easy and appropriate form will be used in all future projects executed for the Health and Care department.

OPTIMIZING ENERGY PERFORMANCE
OF RECENTLY REFURBISHED BUILDINGS IN ITALY

BY **MORENA CAREDDA,** ARCHITECT, ISTITUTO PER L'AMBIENTE E L'EDUCAZIONE SCHOLÉ FUTURO, TURIN, ITALY

"The surveys showed an unexpected interest by the tenants on the technical innovations carried out by ATC in buildings where they live. ATC wants to continue along the course of good practices aimed to increase the involvement of the tenants in order to enhance their awareness and engagement towards solutions with low environmental impact, which are also translated into lower cost for tenants"

INTERVIEW WITH GIANFRANCO TARABUZZI, DIRECTOR, ATC

The Italian pilot sites are located in the North West of Italy in Piedmont Region respectively in Orbassano, Turin and Venaria Reale.

VIA RIESI – TURIN

Via Riesi is from the middle of the 1990's, a traditional Italian construction made by reinforced concrete and bricks. In recent years (2009/2010) ATC replaced the heating system in order to reduce the high demand of energy for heating, of electricity for heating and of DHW. The new system was based on three condensing boilers, and a smart metering system was also installed.

In spite of the improving, tenants still complained about thermal discomfort, higher costs and differences in consumption rates

VIA RIESI EXTERNAL VIEW

among apartments. ATC then decided to implement a solution related to maintenance and further regulation of the heating system – an ADAPTERM system (for further information about ADAPTERM: www.techem.it). The aim of the intervention was to act directly on the heating system and to reduce the problem of thermal discomfort.

This implementation solution was possible thanks to the synergy with BECA project. The case of via Riesi was one of the ATC pilot sites in the framework of the BECA project (*Balanced European Conservation Approach* – ICT services for resource saving in social housing, funded by the Intelligent Energy Programme. For further information about BECA, see: www.beca-project.eu).

ADAPTERM is an "intelligent" system of energy saving, because once connected to the heating unit, it is able to adjust the heat supply of the building with energy and costs consumption. This tool reduces the consumption of energy for heating around 10% after the activation. It is not necessary to manually regulate the heating curves. This also means a reduction of the manual work for the maintenance staff of ATC.

As a conclusion, we can say that ADAPTERM required a considerable investment by ATC. Estimated costs are around 95.000 €. After ESM implementation 43% of the tenants declared that they spent less money for heating bills, and 38% of them noticed positive changes in the thermal indoor conditions.

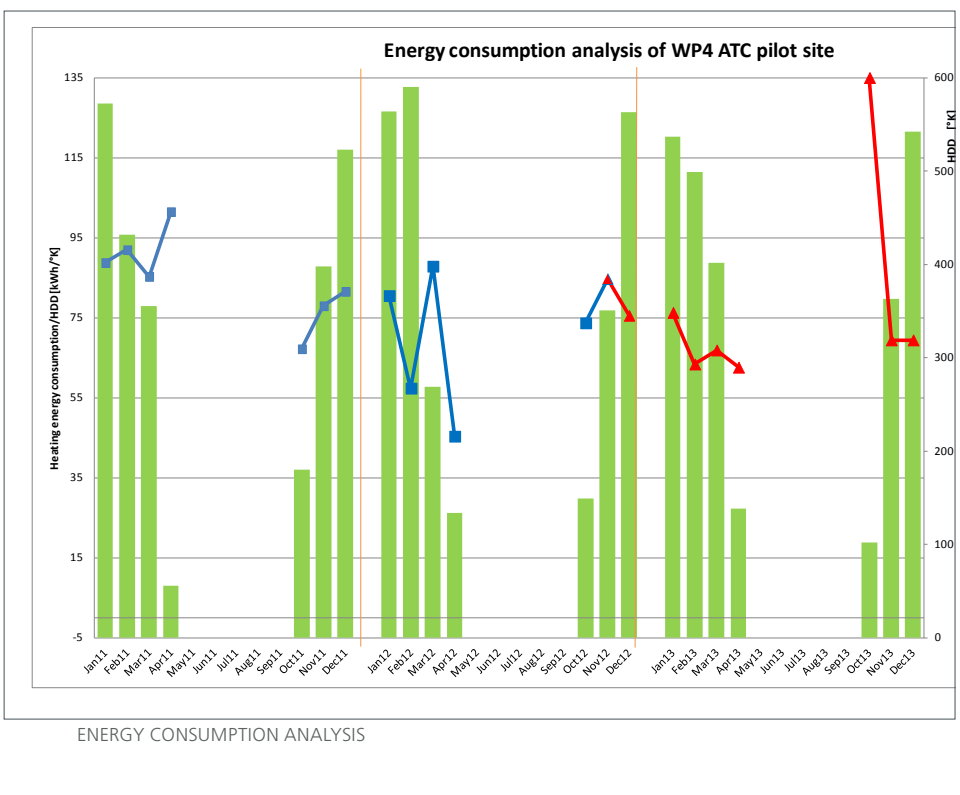
These smart devices work well together with other connected measures like rising tenants awareness about environmental issues and engaging them in reduction of energy consumption. ADAPTERM contributes to the improvement of thermal comfort in apartments. The energy consumption costs decreased in more than 40% in spite of the increasing energy prices. Though – the evaluation of the impact of this optimization solution could be more accurate if monitoring period would be longer.

PASSONI – VENERIA REALE

Passoni was built in 1978. In 2008, the apartment block (12 dwellings) substituted the two old twin boilers (power 98 kW each) with one new condensing boiler (power: 92 kW). Before the tenants produced their own Domestic Hot Water (DHW) with single boilers in their apartments (electrical, most of the time).

The technology used by the burner of the new heating system can reach an efficiency up to 109% and it can allow the reduction of pollutant emissions and fuel consumption. The new boiler technology reduces the number of power on / off operations and have a continuous adaptation to the required minimum of energy, when climatic conditions change.

In spite of this improvement, the tenants still complained about high bills and different consumption rates among single apartments. The optimization solution implemented, were the installation of an insulation cap for the heat exchanger, the installation of four dataloggers in specific apartments and one datalogger for outdoor use. Two thermographies



ENERGY CONSUMPTION ANALYSIS

of the heat exchanger were done before and after the insulation cap installation.

The monitoring period started in April 2013, and in November 2013 the results from dataloggers were analyzed.

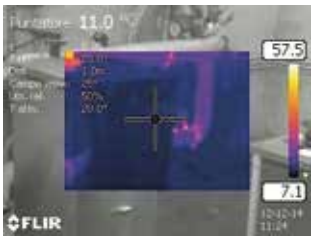
The thermography was the first demonstration of the fact that the insulation cap is able to reduce heat losses, improving the global efficiency of the heating system.

After the replacement of the heating system, the reduction of the energy consumption has been of high values. The energy savings have been in the range of 27-50 MWh per year.

Energy consumption was also compared before and after the implementation of the optimization solution, the insulation cap installation. The results showed the average energy savings were around 3,84 % which is in the expected range.

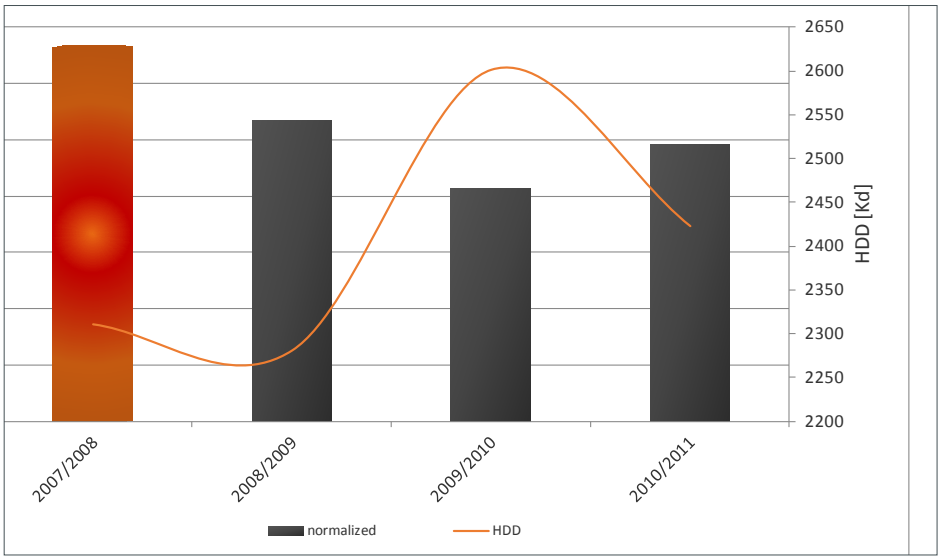
Finally, as a conclusion we can say that the insulation cap for the heat exchanger is a low cost solution, it improves energy efficiency of the building, even if it allows a small reduction of the energy consumption. It would be more cost-effective, if also pipes were insulated.

The technical sector of ATC assumes that the energy saving measures implemented in Via Passoni can be considered the best practice in the framework of the AFTER project. **With an expense of around 300/400€ for purchasing the cap of the heat exchanger, it was possible to achieve a significant reduction of heating energy consumption**. Therefore, the good results obtained ensure that this energy savings measure can be gradually replicated in other buildings with similar characteristics to that one monitored in AFTER.



HEAT EXCHANGER THERMOGRAPHY BEFORE AND AFTER THE CAP INSTALLATION

VIA PASSONI EXTERNAL VIEW



NORMALIZED ENERGY CONSUMPTION BEFORE AND AFTER THE BOILER REPLACEMENT (ESM).

SIMPLE SOLUTIONS FOR BIG ISSUES – FOCUS ON THE SLOVENIAN HEATING OPTIMIZATION

BY **BRANKO ARNŠEK,** TECHNICAL MANAGER OF SPEKTER, TRBOVLJE, SLOVENIA

Oversizing of the heating system is not uncommon in European buildings. During construction, the components are often selected in sizes larger than required to ensure safety margins. But on buildings with good energy performances, or after the application of energy saving measures on the building envelope, this oversizing becomes energy loss. The AFTER team has developed the tools to evaluate the oversizing of the heating system of two Slovenian buildings, and to adjust the heat delivery to their real energy demands, achieving substantial energy savings

The building TR 16, is located in Trbovlje. It is composed of 52 dwellings. The building dates from 1970, and like most buildings of this period, it was never designed to offer good energetic performances to its tenants. On the contrary, the second pilot building SC9b, (13 dwellings) was built in 2006. From the start, it was designed to guarantee low heating energy consumption.

The heating systems of these two buildings are oversized, which is a quite frequent case in the existing stock. Several studies conducted in the EU and also outside EU countries have shown that in general there is a substantial oversizing of the heating systems and of the radiator surfaces in particular. There are several reasons for this. In the design phase of a building, energy losses are often overestimated and in the construction phase heating components are often oversized to keep a "safety margin".

Even though the heating system in TR 16 was hydraulically balanced the energy consumption figures indicated that there was still some potential for further energy savings. This conclusion was also derived from high temperatures of the returning water which meant that the heating system was not operated efficiently.

It has been possible, with measurements of temperatures and energy consumption, to estimate the actual oversizing of the space heating system in the TR 16 building and, from that information, to control the supply tem-

perature in the system for highest possible cooling of DH water at all operation modes. Since the goal was to define the optimized flow characteristics and optimized values of supply water temperature and return water temperature, the full optimization was possible because the indoor air temperature could be measured or estimated with sufficient accuracy.

Due to practical reasons the target is not exact calculations but estimated, based on simplified calculation approach:

The total heat output of the district heating station: **976.920 kW.**

The specific building related heat output of the district heating station: **325.640 kW.**

Exterior design temperature max: te = -10°C.

Interior design temperature: tint= **20°C.**

Specific heat loss that can be covered with the heat output: Pspec = P/dT = 325640/30 = **10855 W/K.**

Annual capacity of heating energy: =Pspec . TP .24/1000 = 10855 . 3500 . 24/1000 = **911820 kWh/a.**

The average annual heating energy consumption is 240.000 kWh/a.

Based on this method of calculation, the Slovenian manager of the building decided to reduce the radiator heat output to 1/3 of its original value. As a result, the lower heating water temperature reduced the heat losses in the distribution pipelines and **6% of heating energy was saved.**

The same method was replicated to the building located in Savinjska Cesta (SC9b). After the calculation of the oversize factor of the heating system, the heating power of radiators was cut by 50%. As a result, mutual effect of temperature reduction with rising tenant awareness led to heating energy consumption reduced by 21%.

The retro commissioning method has proven itself very relevant for the two "test buildings" of the AFTER project. The total costs for the entire optimisation is estimated to around 15 € / dwelling (including technical optimization and tenants awereness measures). Monitoring costs that will not be reapplied for future optimizations, amounted to 175€/ dwelling. Without these monitoring costs, **the initial investment of 15€/dwellings can be compensated in 1 year.**

In the case of Trbovlje, changing temperature regulation in a building connected to municipal district heating system is almost costless for condominium owners and/ or tenants (when you exclude monitoring costs) and as the majority of multi apartment buildings are connected to a district heating system, optimisation has a potential of broader application to the housing stock.

The technical optimization has been completed with a thorough evaluation of its social impact. Tenant survey in the pilot site revealed that, in general, inhabitants are satisfied with their thermal comfort. The majority use thermostatic valves properly and report adequate temperature regulation in their living space, although some of the inhabitants **tend to overheat their apartments with temperatures well over 20°C. In majority tenants'** main motivation is to reduce their energy bills. Only a small share of them is interested in saving energy to protect environment.

Technical optimisation did not lead to any comfort reduction: rooms are warm enough after the intervention. Tenants adapt their heating behaviour (valve setting) due to information and technical change of heating regime. Information lead to slight behavioural change in temperature setting: in some cases lower temperature (19°C - 21°C instead of 22°C - 23°C) is used.

IMPROVING THE DISTRICT HEATING CONTRACT IN L'AIGUILLADE

BY **ALAIN GORAGUER,** TECHNICAL MANAGER AT AUVERGNE HABITAT (CLERMONT-FERRAND) AND **JULIEN BONNET,** AFTER COORDINATOR AT DELPHIS (PARIS)

"L'Aiguillade" is a building from the 60's, recently refurbished by Auvergne Habitat (France) in order to improve its energy efficiency and comfort for tenants. The stake for this testing was to identify how much money can be saved thanks to the refurbishment investment and the building being connected to a district heating system. However, the former district heating contract between the Social Housing Company and the energy provider did not allow to take fully into account the generated energy savings and to decrease the energy bills of the tenants to its full extend. The objective of the AFTER measure was to overcome this situation and optimise the economic gains for all the stakeholders

In 2012, the apartment block L'Aiguillade (126 dwellings), located in Clermont-Ferrand has been completely refurbished by its owner Auvergne Habitat. The main improvements included:

- The refurbishment of the roof insulation (Thermal insulation FOAM glass)
- A new, external thermal insulation (thermal insulation with polystyrene)
- Windows replacement from wood with simple glazing to PVC carpentries with double-glazing
- Improvement of the ventilation system with implementation of an innovative hybrid ventilation system.

L'Aiguillade is connected to the municipal (Clermont – Ferrand) district heating system. As a part of the City sustainable strategy, a new boiler supporting a new energy mix (20% gas, 80% wood) has also recently been installed for the district-heating network.

The new subscription contract between the Social Housing Company and the energy provider has been updated in 2010. Part of this re-negotiation involves a new mechanism to calculate the price for energy provision. This opportunity allows Auvergne Habitat to take into account savings induced by energy refurbishments of the existing buildings connected to the heating network.

CALCULATING THE DISTRICT HEATING PRICES

The pricing for a district heating subscription is divided in two parts:

- A proportional part (identified as R1-factor) based on the quantity of calories consumed by the building during a heating season. R1-factor is obtained reading the energy meter of the building substation (difference between the value for the end of the heating season and

NEW COMPTE WOOD BOILER OF THE «LA GAUTHIÈRE» DISTRICT HEATING SYSTEM (7,7 MW)
PHOTO: FRED MARQUET

Year	2009	2013	
Heating Degree days	2317	2575	11%
Energy Heating	1.255.00	800.620	-36%
Consumptions; domestic hot water (average)	410.000	410.000	0%
Energy consumptions for heating and domestic hot water updated on the contractual basis	1.772.788	1.192.276	-33%
Average power demand	202	136	-33%

the beginning of the heating season).

» A fix part (identified as R2-factor) covers the price of the subscription to the heating network (maintenance, replacement of systems, etc.).

The way the R2-factor part is calculated is a new element included in the 2010 district heating contract.

In the old subscription contract, before 2010, the R2-factor was calculated using the surface of the building. This pricing was not an incentive to implement energy refurbishments. Since refurbishments do not change the total surface of a building, it wouldn't impact the R2. It would be saving energy, but not money!

In the new subscription contract, R2 is calculated using an indicator: the «average power demand». This APD is based, not on the actual consumption of a building, but on its theoretical "need for energy" (both heating and domestic hot water). This "need of energy" is calculated depending on an average energy performance of the building for a fix amount of running hours and adjusted using a fixed average heating period (2516 Heating Degree Days in Clermont-Ferrand).

This new calculation formula is interesting, as refurbishments will immediately lower the "Average Power Demand" of a building, thus decreasing the price for the R2-factor of the district heating.

As Auvergne Habitat has implemented an efficient global refurbishment in 2012 for l'Aiguillade, the APD of the building has been significantly modified. This is a major opportunity for Auvergne Habitat to take advantage of its new contract!

The process led by Auvergne Habitat in AFTER aims at quantifying the energy savings obtained thanks to the refurbishment (including the CO^2 impacts induced by the new energy mix) in order to update the part R2 of its district heating subscription.

Here is the comparison before and after the refurbishment (see figure on this page).

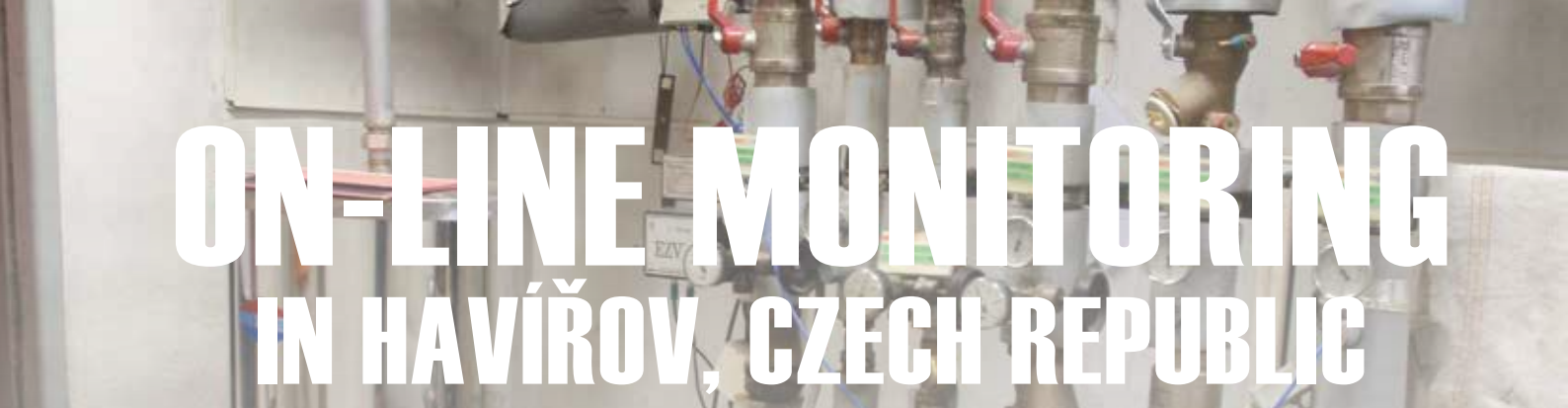
Energy savings related for heating after/before the refurbishment (calculated on a contractual basis with the district heating provider): 42% thanks to the refurbishment.

Savings for heating calculated in EUR regarding the price for energy (included in the district heating subscription contract / R1-factor calculation): 22 518 EUR saved per year (R1-factor price for energy: 38,825 EUR/mWh).

Impact of the modification of Average Power Demand (included in the district heating subscription contract /R2-factor calculation): 12 315 EUR saved per year (R2-factor price for energy: 279,90 EUR/mW).

The heating consumption and the savings linked to the refurbishment are fully reported in the energy bills of the tenants. **The final average yearly energy savings for every one of the 126 dwellings is about 276,45 EURO per year** thanks to the re-negotiation of the district heating subscription for l'Aiguillade.

As a consequence, the optimization of the district heating contract has allowed direct reporting of the impact of the refurbishment on the tenants' bills. At the same time, an energy awareness campaign has been raised by Auvergne Habitat to inform tenants. Their behaviours will be a key factor for the long-term success of the refurbishment.



ON-LINE MONITORING IN HAVÍŘOV, CZECH REPUBLIC

BY **MONIKA KWAPULINSKA,** MRA, CZECH REPUBLIC

The aim of the on-line monitoring is continuously to provide the tenants with information about their energy consumption for heating and their consumption of hot and cold water by means of modern information and communication technologies, and thereby to motivate them to reduce their energy use. At present time, the tenants are once a year provided with information about their hot- and cold-water consumption and energy consumption for heating for the previous year in form of the annual settlement (invoice). At this point, the tenants cannot change the consumption

JABURKOVE

JABURKOVE is a typical multi-residential building from the municipal housing stock. The building was constructed in 1962 according to a national standard known as T02B, and it was refurbished in 2009. It has altogether 36 rental apartments with 73 inhabitants.

ON-LINE MONITORING

The technical solution includes in terms of hardware wireless digital RF 868 MHz thermometers of inside temperature and cold, hot water meters with pulse output that have been installed in the apartments. In the common parts an RF outdoors thermometer; building gateway and repeaters that ensure signal transmission have been installed. Elements are powered with inside long life batteries. Readings of water consumption data, temperatures, energy for heating are done every 20 minutes and transmitted to the building gateway with wireless technology. The gateway is connected to Internet distributions. The consumption data are sent from the building to a central server, where they are stored, processed and visualised to the users on the web portal in graphical and numerical form. The energy consumption for heating per apartment is calculated with the degree-day method. The tenants have received login name and password to the web application.

THE DEGREE-DAY METHOD

The on-line monitoring uses the degree-day method for calculating heating energy consumption in flat. This method measures real thermal comfort. It is suitable for older apartment buildings ("prefabs") with vertical heat distributions. The method is characterized by higher accuracy, objectivity and social fairness than the alternative method of measuring heat radiation flow on radiators. It is based on the actual temperature in the rooms, considering all heat flows, including heat exchange between apartment and out-door environment and also heat exchange between adjoining apartments. This method keeps off disadvantaging users, who have a larger surface contact with unheated areas, or users, whose neighbour spends winter abroad and his/her heating is switched off.

EMPOWERING THE TENANTS

The on-line monitoring has been optimized with education materials that have been distributed to the tenants in paper form and also placed on the Internet web portal. The material includes advice for correct heating – for example correct temperatures in the flat, correct use of radiator thermostats, correct ventilation and tips for water savings. As not all of the tenants have Internet access, the monthly reports about consumption has been sent on paper to the tenants including anonymously benchmarking with the other apartments. The purpose of the benchmarking is to show the tenants column graphs, informing every tenant what his or hers consumption is in comparison with the other flats in the same building, but anonymously.

TEMPERATURE OF THE DWELLINGS

One of the reasons to make the tenants sensitive to their energy consumption is that the indoor heating temperatures of their flat are quite high (21°C up to 24°C). So a compari-

son between the flats is interesting to see the dispersion between the tenants and see, if the on-line monitoring has an impact on their behaviour.

BAD EXPERIENCES

MRA s.r.o. has a negative experience from the past with the use of heat cost allocators installed on the radiators. The apartment buildings in Havířov do not have insulated interior walls and floor structures, which enables the heat transfer between adjacent flats. In the past times some of the tenants used to turn off the heating in their rooms and let the neighbors deliver the heat to them through the separating walls and floor slabs.

This kind of behavior that could be called "heating energy vampirism", also has bad interior environmental consequences (mildews).

CONCLUSION INCLUDING SOCIAL AND ECONOMICAL ASPECTS

The implementation of the ESM has resulted in a reduction of medium indoor heating temperature of 0,5 degrees. Overheating with indoor temperatures of 23 to 24 degrees is still dominant. Sensibilisation, "ecological motivation" and awareness rising are not sufficient. When the novelty of the Internet site that has created curiosity and some interest for a relatively small number of connected tenants fades, and – as time passes – the frequency of connections are reduced, for most tenants it is back to old habits with the search of maximum comfort, especially for elderly tenants or families with children.

The analyses of normalized energy consumption show a notable reduction of 11,7%: From consumption of 123 kWh/m²/y in the baseline period, we achieve a mean consumption of 109 kWh/m².y after the installation of the on-line monitoring.

COMMENTS TO THE CONCLUSION

The main cause of the rather modest results is the absence of economic incentives. Whatever their high or low in door temperature and induced energy consumption, their energy heating bills are still established only in function of the number of square meters they occupy. Without partial or total individualization of heating billing (60 or 50% billing based on individual consumption and 40 to 50%billing based on collective consumption to take in account that some apartments could be disfavoured by their position in the building), there is no individual responsibility of tenants and no economic incentive that are the basis of changes in behaviour.

That is what economists name a price effect that can have a useful and effective impact.

AFTERWORD

In the years 1999-2005 in the housing stock managed by MRA heat cost allocators placed on radiators, were used in order to charge heating energy costs partially according to individual consumption. Since 2006 the legislation does not contain obligation to charge heating energy costs according to individual consumption per apartment.

In 2006 MRA conducted a survey among the tenants, if they wanted the energy cost to be charged to them according to heat cost allocators placed on radiators or only according to area of apartments. More tenants wanted charging heating energy costs according to area of apartment and they did not want to participate in costs of heat cost allocators.

The on-line monitoring strongly motivate the tenants to savings, but inappropriate savings by some tenants cause the increase of presence of mildews and increase of costs paid by building owner to remove mildews. Further more it causes deterioration of the technical state of the building.

ENERGY PERFORMANCE AND TENANTS' INVOLVEMENT – THERE IS ALWAYS SOMETHING TO IMPROVE

A COMPARABLE STORY BETWEEN A GERMAN PASSIVE HOUSE AND A SLOVENIAN NEW CONSTRUCTION

BY **IRIS BEHR,** LAWYER, INSTITUTE FOR HOUSING AND ENVIRONMENT, DARMSTADT, GERMANY

Inhabitants' behaviour becomes more important when all technical saving potentials are exploited. Hot water consumption and room temperature setting as well as use of electrical appliances are the keys for further energy and cost savings. Clear and regular information is necessary for proper heating and cooling, also for understanding the connection between comfort and cost: lowering the passive house room temperature by 1° C brings a heat reduction of 15 %, the change of the hot water regime can achieve up to 9 % saving

Both the German Passive House built in 2010 and the Slovenian new construction of 2006 have a very good energy performance from the very beginning due to the technical layout. It was assumed that the optimisation would not be a technical one but a human one. Consequently the AFTER approach to investigate the impact of low investments performed after the established ESM (Energy Saving Measure) (i.e. the new construction) concentrated on the inhabitants' contribution. Saving potentials under the control of the inhabitants exist in the field of hot water consumption and room temperature. It turned out that energy and cost awareness can be increased by such activities and a change of behaviour in respect to a conscious treatment of resources (energy and water), i.e. the improvement of the inhabitants' eco-empowerment is possible.

The tenants of a passive house in Darmstadt and the owner occupiers of a conventional new building in Trbovlje, Slovenia have been interviewed on their energy related behaviour, i.e. heating habits, their way of consuming hot water and their use of electricity. The inhabitants have been asked on their present satisfaction with the issues mentioned. Their expectations on energy saving potentials in general and in respect to the particular optimization measures, as well as their overall environmental protection attitudes have been investigated. Their ideas in respect to information on energy saving and proposals for improvement have been of relevance in the surveys.

WHAT HAS BEEN DONE IN DARMSTADT?

The saving potentials of passive houses are very limited. Used heating energy is already very low. Therefore the hot water delivery was investigated. All the 44 families of the 4 storey-passive house show a very high interest in the passive house as such and the connected energy saving potentials of the hot water delivery. Hot water production and the needed energy equals to nearly 50 % of the whole energy consumption in a passive house[1]. Even if the absolute saving figures will be small, the assumption was that some 7 % savings would be achieved[2].

While the technical intervention was small,

stopping the circulation pump for several hours during the night, the legal and tenants' impact was important: German court rulings demand hot water delivery with very little delay (not more than 3 liters in order to reach 55 ° C hot water). New health standards (2013) demand 55 ° C in order to prevent the breed of legionella. It is this prerequisite that limited the stop of the circulation pump to 6 hours between 11 - 5 instead of the planned 8 hours per night.

Tenants' acceptance of the technical optimization measure was not only desirable but a must in order to avoid legal court cases. Therefore a manifold tenants' approach was chosen.

TENANTS' INTERVENTIONS

In summer 2013 during a first tenants' meeting at the premises of the pilot site, WohnArt3, the overall information of the AFTER project, the results of the water consumption data and the intended optimization were introduced. The prepared tenants' survey was pretested together with the participating tenants. There were valuable recommendations to improve the questionnaire.

The tenants took the chance to present other recommendations and complaints going beyond the hot water issue. The recommendations mainly addressed the existing handbook " Leben im Passivhaus" ("Living in a passive house") which had been handed out to all tenants when they moved in the year 2010.

All issues touched (heating and shading, air dryness, doors and window insulation, maintenance of particular passive house technical equipment) are of high interest for the SHOs and useful for the **retro commissioning process** (see article about *Successful retro-commissioning process in Lystrup*).

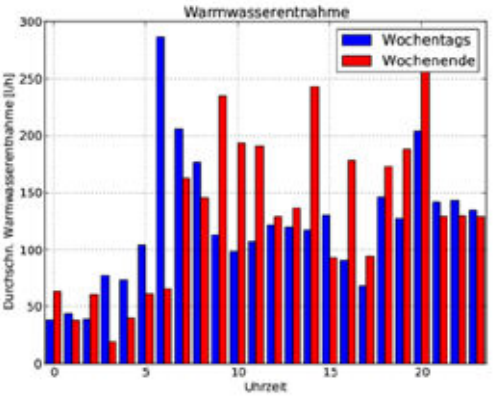
RESULTS

The questionnaire asked for satisfaction, awareness and knowledge as well as behaviour of the tenants. Out of the 44 households 27 households participated in the survey. The overall satisfaction with the "living situation" is very good: 80 % of the households are satisfied with their present living situation. The passive house standard and the expected low heating costs had been a motive for renting a flat in the passive house. For **77 % of the households the passive house standard was a reason to choose such a flat.** Putting the questions slightly different and asking for low heating costs in the passive house, 40 % focus on the savings in heat costs, 35 % stress the contribution to climate protection while 16 % appreciate the high comfort going along with the passive house.

The awareness and knowledge on the passive house technologies is very high. More than 77 % are well informed on the particular passive house technology. Means of information are broadly spread – the handbook is one amongst many. It was suggested to publish an English version of the handbook for the tenants. Additional information is requested in respect to water saving, proper heating and shading in particular addressing the controlled heating system. The indoor climate is seen as a difficult issue for 54 % of the inhabitants.

An amazing high proportion of 91 % is interested in energy-cost-saving and even more inhabitants (96 %) are well aware of the environment.

Looking at the particular issue of hot water delivery and saving there is a very high satisfaction (73 %) with the hot water delivery before optimisation. A huge majority would accept 40° temperature for rinsing the dishes (82 %) and hot water for showering



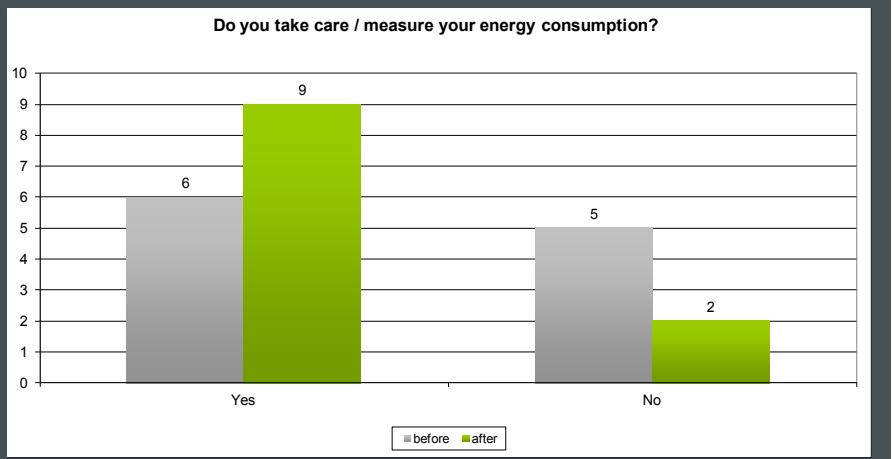
COMPARISON OF DOMESTIC HOT WATER CONSUMPTION PEEKS DURING WORKING DAYS (BLUE) AND WEEKEND (RED) (GRAPH)

(72 %). A majority of 91 % finds a hot water delay during the night very acceptable. In order to save energy costs 78 % would accept a comfort reduction.

The described opinions and expectations are in line with the tenants' habits in respect to water consumption. 81 % of the households use water saving appliances like toilet flushes, warm water connection for dishwasher and washing machine, water saving shower appliances and water saving taps. The tenants report that they take a shower instead of a bath and use cold water for hand washing instead of warm water. The dishwasher and the washing machine run only while the machine is fully loaded at 90 % of the households.)

In February 2014 a second tenants' meeting took place, where the above-described results were discussed, and the personal opinion of the participating tenants were exchanged. The new water regime has been well received and no real complaints have been expressed.

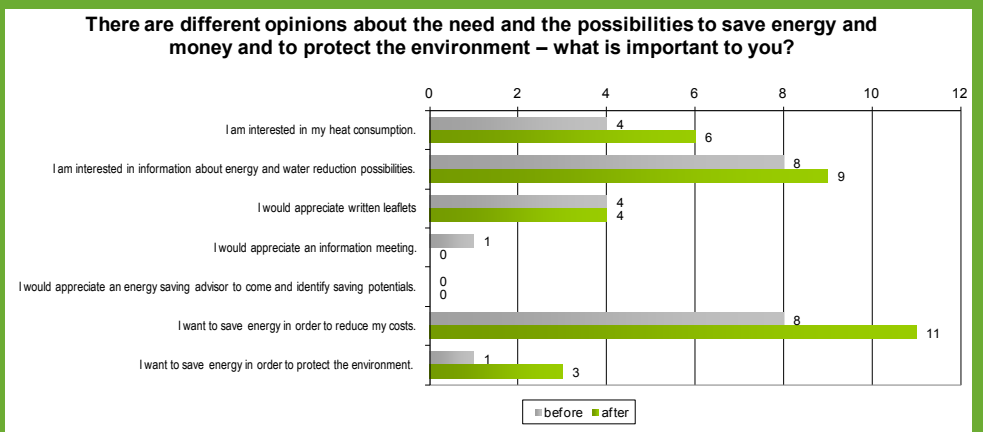
Looking at the consumption measurements there is still some patience required. Results will only be visible after a full year of measurement, i.e. in the late autumn of



2014. Up to now just the winter period has been measured because the change of the circulation pump regime took place in September 2013. As the baseline is 12 months to compare the new monitored consumption the results will be presented at the end of the year. However this "delay" offers the opportunity to stay in touch with the tenants, meet them again at the end of the year 2014 and continue with the eco-empowerment.

WHAT HAS BEEN DONE IN TRBOVLJE, SLOVENIA?

While the WohnArt3 passive house inhabitants belong to an enthusiastic and well educated clientele, the Slovenian example of the 2006 new construction a 6-storey residential building, Savinjska cesta 9b in Trbovlje (see a building description in the article on *Simple soulutions for big issues*) with 13 families is a conventional new construction with owner occupiers. It is connected to the district heating. Each apartment has several radiators with built-in radiator valves with thermostatic heads. Hot domestic water is heated individually with electric boilers. Looking at the energy consumption it was assumed that the heating system is oversized by a factor 4. As the heating system was arranged to 90/70 (dT 60 °C)[3], the incoming water is unnecessarily hot. Because of this the heat losses in the network are too high. Therefore the heating regime of 90/70 (dT 60 °C) was reduced to 50/40 (dT 25 °C) – thus the thermal power of the radiators is reduced to one half. In addition the heating regulation set a shallow slope by lifting the curve for 5 °C with 50/40 slope. The technical intervention was combined with the empowerment of the owner occupiers aiming at a reduction of energy losses by 5 % thus giving 5 % energy saving.



INHABITANTS' INTERVENTIONS

Due to the small number of households they have been interviewed face to face at their homes. 11 of the total of 13 households with 33 inhabitants (equalling 85 %) participated in the 2 interviews before and after the optimization measure. As the interviewer came to the homes of the inhabitants, the occasion was used for detailed information on the new temperature regulation and energy savings and costs. The inhabitants were taught how to use the thermostatic valves, how to ventilate properly and how to heat. The inhabitants received a flyer on energy saving and reduction of heating costs.

RESULTS

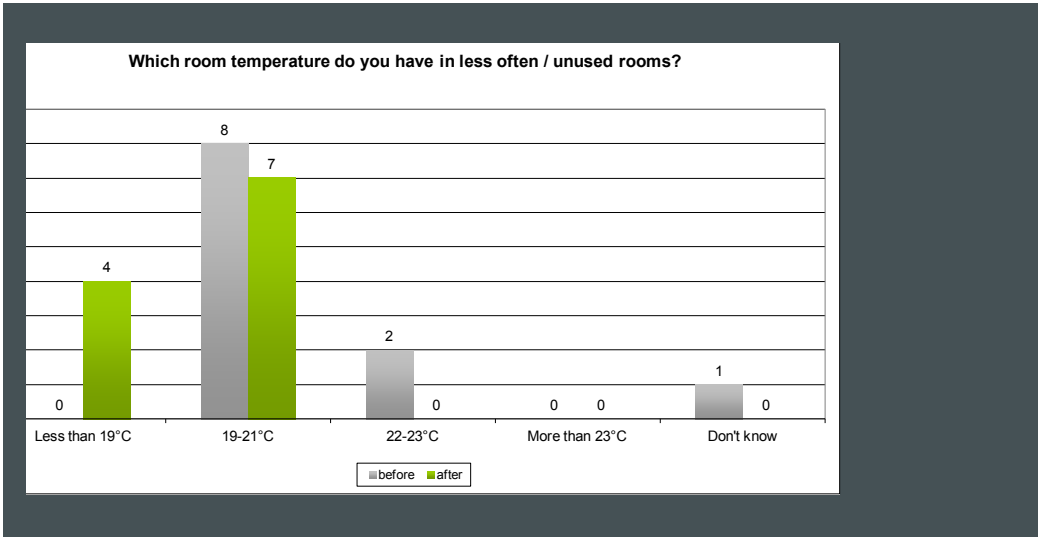
The topics addressed in the interviews were the satisfaction with the (new) room temperature as well as the desired and achieved room temperature, the interest in energy (costs) saving and the overall environmental protection interest.

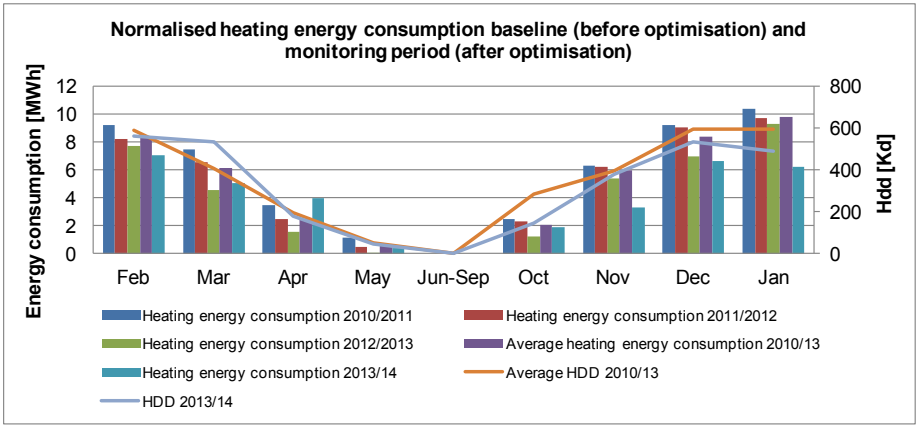
Satisfaction with the delivered heat is very high. This was the case before the optimization and there is no change afterwards. During the optimization phase the awareness for energy consumption had clearly increased. Households being satisfied with a room temperature in often used rooms of 19 - 21 °C doubled while the desired temperature of 22 - 23 °C in more often used rooms decreased by 50 %. There is no household that wants temperatures above 23 °C.

All households want to save energy costs and are interested in adequate information materials.

Summarizing the effects of the inhabitants' survey and information campaign **a very positive behaviour change can be stated.** The results from the second survey show that now more inhabitants do control their energy consumption. The inhabitants can check the energy invoice and the information on energy provider's internet portals as well as checking the meters in the hallway, which monitor the electricity consumption.

Looking at the graph* a positive result on energy saving can be identified. While the awareness had risen the actual heating consumption has gone down in the testing phase. The evaluation of the consumption data shows an energy saving of at least 6 % if one takes a very careful point of view: within the 3 year baseline the period 2012/13 showed an inexplicably low consumption. Comparing, however the consumption data with the 3 year average **the savings mount up to 21 %.** There are different reasons for the exceptional low consumption in 2012/13: prices had risen and heat cost distribution had changed to a consumption based approach. Also a change of behaviour must be taken into consideration.





[1] Besides the net rent of 10 € per month and m² tenants of WohnArt3 have to pay a flat rate of 0,30 €/m²/month for heating , for hot domestic water 0,28 €/m²/month and cold domestic water 0,36 €/m²/month. Costs for cold and hot water are billed once a year.

[2] The project eSESH which is a little ahead of the After findings showed that the water heating reduction leads to 9 % savings in some 358 dwellings.

[3] **90/70 (dT 60°C)** stands for 90°C flow temperature and 70°C return temperature (heat system temperature) leading to a mean temperature of 160°C :2 - 20°C room temperature= 60°C

ENERGY CONSUMPTION DATA

COLLECTION AND INTERPRETATION OF RESULTS

BY **TOMAS VIMMR,** STU-K, PRAHA, CZECH REPUBLIC, **MARTA SKUBIC** AND **MARJANA ŠIJANEC ZAVRL** BCEI ZRMK, LJUBLJANA, SLOVENIA

In the AFTER project fine-tuning energy saving measures in 18 buildings from 6 countries were implemented in order to optimize the operation of the building after the various renovation investments were done. In order to monitor the impact of the energy saving measures the energy consumption before and after was recorded. The old data on energy use before the investment are usually available on the annual basis; however in the AFTER project the impact of the fine-tuning energy saving measures were in most cases measured in a monthly time period. In order to assure comparability of the monitored data, certain impact factors (various climatic conditions, usage profile, and number of inhabitants)

The AFTER project has led to interesting results that can help to improve the quality of the management of the housing stock for the SHOs and, in general, may serve as a basis for actions aimed at the energy saving in any private building.

The following contribution focuses on the normalization of measured energy consumption with regard to the actual climatic conditions on the building site. For the particular location the data for monthly heating degree days (HDD) in consequent years are needed, in order to compare the impact of investment and optimization measures, with respect to the initial energy use.

HDD is a tool that can be used in the assessment of building energy consumption over a specified time period related to the weather.

The calculation of building energy use with heating degree days is one of the simplest calculation methods, based on the assumption that within the reduced accumulated temperature difference (i.e. degree days) the impact of internal and solar gains is incorporated (EN ISO 13790, ISO 15927-6). This reduced subset of the accumulated temperature differences used in a degree-day method is determined with respect to the pre-defined base temperature, i.e. if the later is lower than the internal set-point temperature then the temperature difference is added to HDD. The selection of a base temperature and thus the reduction of the accumulated

temperature difference is done as a rough assumption, without the knowledge of the specific heat-balance ratio (ratio between gains and heat transfer) due to the thermal characteristics of the building and the internal and solar gains. The base temperature may therefore differ from country to country and it depends on the climate, targeted indoor temperature and thermal comfort level, respectively, and on prevailing construction tradition (typical building) in the country.

Normalization of measured monthly energy consumption data with heating degree days is thus based on the above described very rough and most simple calculation method. One must be aware of the accuracy limitations of this approach due to the fact that the base temperature of heating DD provided in the country is only a rough assumption, the number of weather stations in the country is limited and the temperatures for other locations are simulated and cannot reflect the specific micro location of the building site.

The sufficient quality and quantity of collected energy and cost data is essential for reliable evaluation of implemented energy saving measures on 18 buildings in this project. Using the most relevant Heating Degree Day data (HDD) in the calculations is an important step in the assessment of the energy savings. The AFTER project has developed its basis as follows.

In the boxes you see an axample of the general formula. And after that an example is shown on how to calculate on a monthly basis. More information can be found in the "AFTER Handbook" on the website www.afterproject.eu..

HDD are used to calculate so called normalized energy consumption that makes it possible to quantify the actual energy savings by taking into account the variability of climatic conditions in

GENERAL FORMULA:

$EC_{normalised} = (EC_{period} / HDD_{period}) * HDD_{average}$

EXPLANATION:

$EC_{normalised}$ = Energy consumption on the period with HDD correction
EC_{period} = Energy consumption on the period without HDD correction
HDD_{period} = real HDD on the period
$HDD_{average}$ = average HDD defined for a period of several years.

Analysis made on the basis of monthly data of energy consumption

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

AN EXAMPLE:

If we made the implementation of an energy saving measure by the end of October 2013, we will have data about the energy consumption from November 2013 until today – e.g. March 2014. We can then compare the energy consumption for the same period (November 2012 - March 2013, compared with November 2011 - March 2012 … etc.) for the five previous years.

This gives the following formula for the normalized energy consumption in the period (November 2013-march2014):

$EC_{2013-2014} = (ECn*HDDnov/HDD_{nov13} + ECd* HDDdec/HDD_{dec13} + ECj*HDDjan/ HDD_{jan14} + ECf*HDD_{feb}/ HDD_{feb14} + ECm*HDDmar/ HDD_{mar14})$

EXPLANATION:

$EC_{2013-2014}$ (normalized energy consumption in period November 2013-March2014
ECn…(energy consumption in November 2013)
ECd… (Energy consumption in December 2013)
ECj…(energy consumption in January 2014)
ECf…(energy consumption in February 2014)
ECm…(energy consumption in March 2014)
HDDnov…average HDD for November in last 5 years
HDDdec… average HDD for December in last 5 years
$HDD_{nov13.}$.. HDD in November 2013

different years. Weather normalization or weather correction of energy consumption enables a comparison of energy consumption from different periods or places with different weather conditions.

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

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

To calculate the normalized energy consumption following data is needed:

- Monthly energy consumption in kWh for the baseline period (at least 12 months) and the monitoring period. [1)]
- Local monthly HDD from the baseline and the monitoring period.
- Monthly average of HDD for at least five years back (calculate the average by adding the HDD for the same month five years back and divide by five).

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

For an existing building without a known baseline, it is possible to gather the average energy use per m^2 from buildings from the same period or from one building from the same period and then calculate the same way as for new low energy buildings.

ABOUT THE METHODOLOGY

To establish a common and comparable basis on European level in the AFTER project, we would have liked to use the method that EUROSTAT defined for the calculation of heating degree days:

HDD: (18 °C - Tm) x d if Tm is lower than or equal to 15 °C (heating threshold) and are nil if Tm is higher than 15 °C, where Tm is the mean (Tmin + Tmax / 2) outdoor temperature over a period of d days. Calculations are executed on a daily basis (d=1), added up to a calendar month – and subsequently to a year – and published for each Member State separately.

We did this on our pilot sites, where data about HDD on Eurostat methodologie were available.

Else we have used HDD on national/local basis.

HDD ON NATIONAL / LOCAL BASIS

HDD of the season is the sum of daily temperature differences between reference indoor temperature (X° C) and a mean daily temperature of the external air in those days, when the daily mean temperature is lower than or equal to Y ° C (heating threshold). Tm= is the mean (Tmin + Tmax / 2) outdoor temperature over a period of d days

HDD: (X°C- Tm) x d if Tm is lower than or equal to Y °C (heating threshold) and are nil if Tm is greater than Y °C.

For calculations relating to any particular building, HDD should be selected with the most appropriate base temperature for that building. However, for historical and geographical reasons HDD are often defined with base temperatures of 60 °F (16 °C) or 65 °F (18 °C)—base temperatures that are approximately appropriate for a good proportion of buildings. However, base temperature of 17 °C (63 °F) is used at least in Finland and Denmark, and also 19 °C (66 °F) is used in some other EU countries. Because the base temperature can be chosen and it can therefore vary, the base temperature used in calculating the heating degree days has to be presented.

Where nothing else is mentioned in the overview of the national HDD, the heating threshold is – to our knowledge – equal to 15 °C (outdoor temperature).

CONCLUSION

There are a several ways in which HDD can be calculated. The more detailed recording of temperature data, the more accurately the HDD can be defined. HDD are often calculated using simple approximation methods that use daily maximum and minimum temperature readings instead of more detailed temperature records such as half-hourly readings.

Calculations using HDD are raising several issues. Heat requirements are not linear with temperature and heavily insulated buildings have a lower "balance point" than buildings in the southern part of EU territory (with the exception of mountain areas). The amount energy required for heating depends on several factors besides outdoor temperature: How well insulated the building is, the external and internal heat gains such as the amount of solar radiation reaching the interior of a house, the total energy output of domestic appliances running in the household and the number of persons in the flat. Another important factor is the amount

of relative humidity indoors. The building's thermal response may also be impacted by the velocity and frequency of wind, the snow cover, the sky conditions (cloud cover).

Another problem with HDD is that care needs to be taken if they are to be used to compare climates internationally, because of the different baseline temperatures used as standard in different countries and the use of the Fahrenheit scale in the US and the Celsius scale almost everywhere else. This is further compounded by the use of different approximation methods in different countries and by use of EUROSTAT data. Unfortunately, EUROSTAT monthly data for NUTS 2 regions are available only until 3/2010.

In the AFTER project we have included all the knowledge, and we have used it for choosing a reliable, but pragmatic solution.

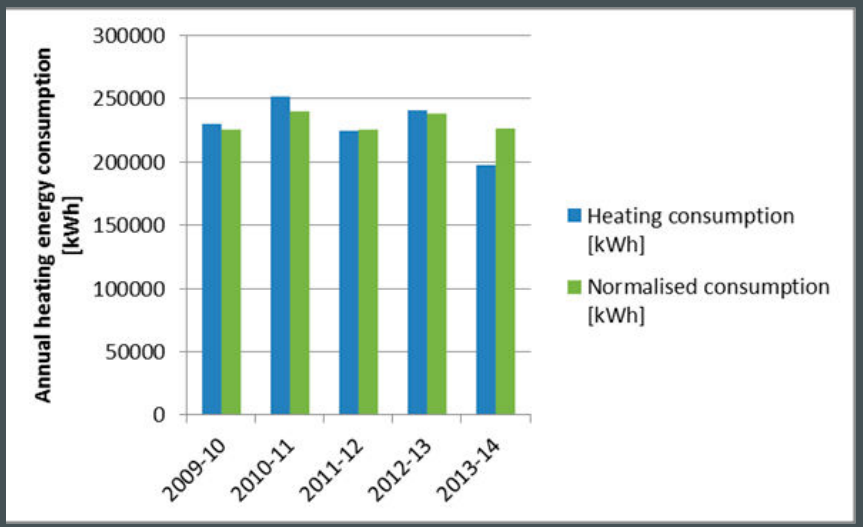
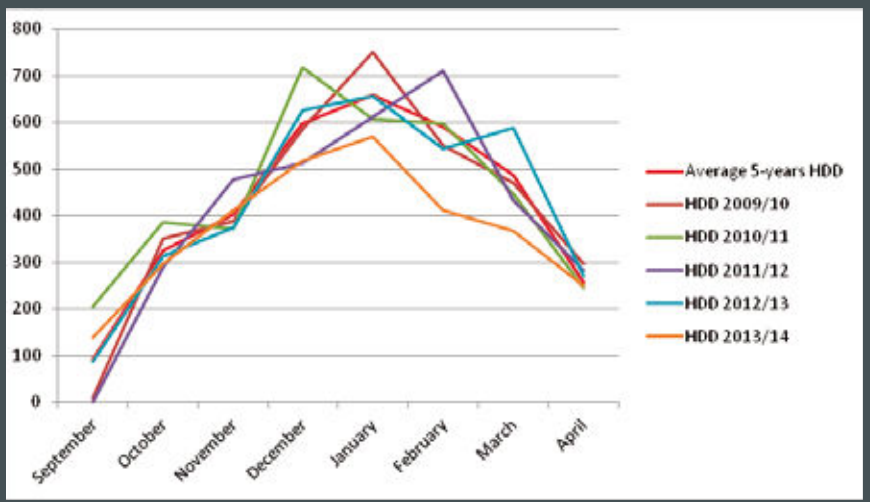


FIG. 1. DIFFERENCE BETWEEN REAL AND NORMALISED HEATING ENERGY CONSUMPTION IN HAVÍROV (CZECH REPUBLIC), HEATING SEASONS 2009-2014

FIG. 2. HEATING DEGREE DAYS IN HAVÍROV (CZECH REPUBLIC), HEATING SEASONS 2009-2014



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

www.afterproject.eu

The partner organizations of the AFTER project are being presented below. The partners have cooperated for three years to highlight and evaluate the most efficient and adaptable energy saving measures in existing and new buildings. The project has shown that the optimization of buildings' performances will become an issue as important as the technical innovations, because the social housing sector cannot afford a building that does not function in a fully optimal manner. In this magazine you can read about the project results.

PARTNERS

PARIS (FR)	DELPHIS	www.delphis-asso.org/
CLERMONT-FERRAND (FR)	Auvergne Habitat	www.auvergne-habitat.fr/
PARIS (FR)	CSTB	www.cstb.fr/
PARIS (FR)	USH	www.union-habitat.org/
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