Balanced European Conservation Approach

ICT services for resource saving in social housing

FINAL REPORT

Project Acronym: BECA

Grant Agreement number: 270981

Project Title: Balanced European Conservation Approach

Period covered from 01.01.2011 to 31.12.2013

Authors:

Georg Vogt	empirica
Eriona Dashja	empirica
Werner B- Korte	empirica

Project coordinator name, title and organisation:

Werner B. Korte

empirica Gesellschaft für Kommunikations- und Technologieforschung mbH

Tel: +49228985300
Fax: +492289853012
E-mail: BECA@empirica.com

Project website address: www.beca-project.eu

Executive Summary

Energy efficiency investments are a cost-effective means for decreasing energy consumption, reducing energy bills and reducing the likelihood for energy poverty. The BECA solution, offering resource management (RMS) and awareness, services based (RUAS) on ICT and smart metering, achieved 15% savings for heating, 11% for cold water and 17% for hot water. Savings amount to 570MWh which equals 177 tons of CO_2 per year. Financial pay-off is achieved by most stakeholders during the first 3 years and by almost all stakeholders after ten year across seven pilot sites in seven countries. The socio-economic net benefit for the BECA project, extrapolated for ten years, amounts to €1.7Million in pilot buildings alone.

Project Summary

In BECA, ICT-based services for social housing tenants have been evaluated in 7 pilots in 7 countries across Europe as depicted in the map. More than 5,000 social housing tenants have access to BECA Resource Awareness and/or Resource Management Services in the pilots, which are designed to evaluate the impact on overall residential energy consumption. In each pilot site an integrated approach is followed, involving a team of different partners with corresponding skills and expertise working together to successfully implement and operate the different services. Typically, a pilot site team includes a social housing provider, an IT service provider responsible for the development and implementation of the web-based services and in some cases also a utility and energy provider.

The BECA solution is based on Smart Meters measuring amounts of energy or water flowing through them and capable of communicating the readings autonomously every few minutes to a centralised server. Two major service categories are distinguished: Resource Awareness Systems (RUAS), which provide tenants with greatly enhanced, timely feedback about their energy use, and Resource Management Systems (RMS), enabling end users (tenants), housing providers and/or energy providers to manage energy consumption in smart ways, leading to greater efficiency and lower GHG emissions.

Five key stakeholders are identified by the project along with public authorities (policy makers, local city councils). Social housing companies provide living space and are the main reference point for all stakeholders including tenants. Once responsible for reading of traditional meters, the measurement provider adopts a new business model using new technologies often developed by IT-companies. In most pilot sites the energy provider remains passive or, in some cases, is actively hindering access to building infrastructure and / or the collection of data required. Lessons learnt are provided for all stakeholders.

Approach and Results

The first four work packages established a common technical documentation harmonising the documentation of all designs. User recruitment (WP5) and Operation (WP6) ensured that the systems developed are successfully implemented in the field and tenants as well as professionals have the necessary training to operate the systems. A key result of the project is the provision of a 'Guide for replication' following project's work programme consisting of nine work packages of which three were horizontal activities such as evaluation, dissemination / exploitation and management.

Evaluation of energy savings is based on 24 months of baseline and intervention data accompanied with control group designs and before / after surveys. The methodology used is based on the common practise agreed with all CIP-projects in this domain in which BECA-partners were particularly active (IWU, empirica). The quantitative analysis was performed using the EC-tool 'eeMeasure' which has to be used by all CIP-projects to assess and publish the savings achieved in the project on the same platform. eeMeasure was developed and hosted by empirica.

Exploitation was assessed using a standardised cost benefit analysis (CBA) widely based on the guidelines provided by the EC. The tool compares a 'do nothing' scenario with the installation of BECA. Based on numerous implementation (CAPEX), operation (OPEX) and consumption indicators up to eight stakeholders can calculate (and model) their own cost and benefits as well as the socio-economic return for the entire pilot. The tool was developed by empirica.

Impact

For the resources covered by the majority of sites savings of 15% for heat energy, 11% for cold water and 17% for hot water have been achieved. Only for electricity the target was not met (2%). However, it has to be taken into account that the most effective way to achieve meaningful electricity savings is to replace old electric appliances by new and less energy consuming ones. The tenants of social housing often do not have the means for doing so and assess it as not useful to replace appliances when the old ones still work well. As all pilot sites will continue the provision of their services they can base their future campaigns, energy coaching and further activities on the current success of the project.

Economically, all sites proof to pay-off within a few years and almost all stakeholders achieve net benefits compared to the 'do nothing' scenario. The average implementation cost for the BECA solution is 300€, the average yearly operational cost is 17€. Modelling a full deployment of BECA for 7,000 dwellings –1,000 dwellings per pilot over a period of 10 years – would result in a net benefit of €5.91 million.

Socially, the risk of energy poverty can be reduced by given tenants the information necessary to control their own consumption. This is of particular importance in Eastern Europe where individualised billing is just being introduced and those with above average consumption will pay higher bills in the future. Deployment of the BECA solution can be easily combined with increasing IT-literacy among elderly and poor. Moreover, communication among tenants was improved to the extent that 'champions' became known experts acting as energy managers helping others and potentially learning skills required on the labour market.

Exploitation

Pilot Exploitation analysis has proven that working services are viable under the given conditions. Total return on invest – for all stakeholders in the pilot site together - is reached across all sites within a few years. This does not imply that an individual stakeholder might require a few more years to get their investments back. Degree of functionality correlates with technical requirements and costs. This correlation is particularly strong for implementation costs but also holds for operation costs since financing the investments is often based on future payments. Sites, in which consumption based billing is not the standard ('Do-Nothing' scenario) require more years to break even. A main reason being that infrastructure not present and the need for additional effects to be accounted for (e.g. more communication).

The SWOT highlights the importance of local conditions for implementation. For many tenants, the concept of paying their own energy consumption (and not a lump sum) is new as is the fact that with the BECA services they are being enabled to influence this and thereby the amount to be paid. The differences across sites are not limited to internal strengths and weaknesses but also face varying opportunities and threats often resulting from regulation and current market players.

A key result of the project is the provision of a 'Guide for replication' following the structure of the work programme. The Guide collects the most successful measures to be taken and provides stakeholders with checklists for key steps. Along with the organisational and process guidance, the Guide also provides technical documentation. The 'BECA solution' use cases, process models and architecture enable the reader to select the elements most suited in any given environment and approach stakeholders with the elements to be part of the solution.

Conclusions and Recommendations

The BECA solution can be applied in all circumstances. The RMS element should be deployed first to collect "low-hanging fruits" such as energy wastage. The RUAS element has to be deployed as part of a long-term strategy and is ideally integrated with other web-based services. Both services help to detect faults and reducing costs of infrastructure maintenance along with reducing resource consumption.

In Eastern Europe, consumption is currently being billed by surface and individualised billing based on own consumption is just being deployed. Hence, smart metering should be the tool of choice to implement the new billing regulations resembling a great opportunity for ICT services. However, adverse effects have to be considered as the BECA service was sometimes blamed for the increased cost of (individual) consumption as it was falsely linked to the billing rather than being seen as an additional tool. Transparency and early advocacy of the changes to come and the ICT service is crucial. Characters such as the depiction of BECO (see Manresa pilot) can help to explain the service and motivate champions as well as children and elderly.

Tenants must be made aware that living in a well insulated building does not automatically lead to low energy cost. In fact, their behaviour is of even greater importance: Speaking in relative terms of total consumption, leaving a window open does more harm in well insulated house. Smarter energy behaviour is also relevant in economical terms as the cost for insulation have already been paid for. Not fully "utilising" the insulation implies delaying the return on invest. BECA services are a cheap way of detecting wastage, giving advice and pointing at the tenants who might require additional energy coaching.

Barriers for BECA-like services remain with the restrictions upon exploiting the full potential of smart-metering based services. This becomes even more relevant when existing (local) actors create restrictions regarding access to hardware or data hereby increasing cost and risk for service providers. Barriers on the demand site include a lack of trust in smart-metering. Generalised exploitation scenarios are outlined for exploitation driven by public institutions, newcomers and market players. Stakeholders considering a scenario should validate their own situation with the lessons learnt provided in the 'Guide for Replication'.

These and other lessons learnt are collected in the 'Guide for replication' strongly recommended to any reader planning to deploy the 'BECA solution'. The Guide contains technical and organisational documentation combined with checklists allowing stakeholders to efficiently plan steps and monitor their process.

## Table of Content

List of Exhibits

1   Project Summary

1.1 Project Objectives

As part of the ICT PSP programme of the European Commission Competitiveness and Innovation Programme, the BECA project aimed to design, develop and pilot new solutions to enable sustained reductions in energy consumption across European social housing. This was accomplished firstly by providing usable ICT-based services for Resource Management (RMS) and Resource Awareness (RUAS) directly to tenants, secondly by providing effective ICT monitoring and control of local generation of power and heat and thirdly by providing social housing providers, regional and national government with the data they need to optimise their energy-related policy and investment decisions at national, regional and organisational level. The project helped Europe meet emission targets by achieving a significant reduction of energy consumption in European social housing.

BECA Advanced Resource Awareness Services (RUAS) provide direct, timely and comprehensible feedback on energy consumption, enabling tenants to adapt their energy consumption behaviour. An RUAS graphically visualises the energy (heating, electricity, water) consumptions which enables tenants to easily grasp this information and evaluate it in terms of whether their consumption is to be judged as high or not and in comparison to other consumers and over longer periods of time. The tenants get access to these services (RUAS) through a web-based platform, a smart phone application or – in some pilot site dwellings through the TV set - which allows them to quickly and easily obtain consumption information at monthly, daily or even shorter time-intervals. Also they are able to compare their consumption to those of other tenants or an 'average' tenant, energy consumption by square meter, comparisons of consumption in the past and present year and month etc. The information is provided in a way showing the developments over the years and allows tenants to take appropriate action in case they judge their consumption figures to be too high. Some of the RUAS implemented in pilot sites create tips for tenants on how energy consumption and costs can be saved based on the observed consumption patterns and figures.

In addition, a comprehensive set of Resource Management Services (RMS) help reduce consumption peaks and optimise the timing of domestic consumption. Optimised timing of consumption can reduce generation capacity requirements and, with appropriate tariffs, tenant costs. RMS are also used to control delivery of locally generated, renewables-based heat and power.
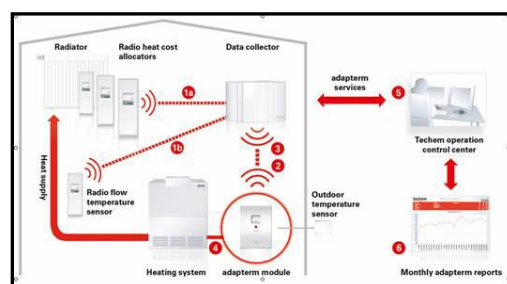
1.1.1   Pilot Sites

These new ICT-based services for social housing tenants have been evaluated in 7 pilots in 7 countries across Europe as depicted in the map.

More than 5,000 social housing tenants have access to BECA Resource Awareness and/or Resource Management Services in the pilots, which are designed to evaluate the impact on overall residential energy consumption. In each pilot site an integrated approach is followed, involving a team of different partners with corresponding skills and expertise working together to successfully implement and operate the different services. Typically, a pilot site team includes a social housing provider, an IT service provider responsible for the development and implementation of the web-based services and in some cases also a utility and energy provider.

1.1.2   Activities

Today the RUAS and RMS services are in full operation in all BECA pilot sites. Comprehensive evaluation work was carried out in all pilot sites and this included energy consumption measurement and tenant survey data analysis. All results were reported in specific deliverables which are made available to the public.

High profile dissemination activities including the 'European Sustainability Week' (EUSEW) and attendance and presentations at further high-profile events at national and European level were further project activities together with the successful organisation of national workshops in cooperation with other European projects.

An assessment of the viability and cost-benefits of the BECA services and reporting about these for each actor group in the pilot sites was conducted on which the exploitation plans for future service operation and roll-out activities can be based.

Finally, an BECA guide for replication of BECA services within pilot sites and very importantly by other actors from outside BECA has been developed to support a Europe-wide demonstration, implementation and roll-out especially in social housing but also beyond.

A key achievement was to invite other projects to cooperate in the 'Guide for Replication' with other projects which has been successfully achieved with eSESH.

Partners

The BECA project was led by social housing providers and in some pilot sites relevant government authorities and was coordinated by empirica Communication and Technology Research, Bonn. Contributors included global players in electricity supply, smart metering and home / building automation and international players in building networks and tenant portals as well as local specialists, ensuring a high standard of technical work and the achievement of key project objectives at each pilot site.

For further information the interested reader is referred to the BECA website (www.beca-project.eu) where the public outputs and deliverables of the project can be obtained including the common BECA services and systems requirements specifications, common use cases, process models and the common BECA system/service architecture, all developed using standard notations like UML and BPMN 2.0 to ease replication of service development, implementation and operation by third parties interested in the replication and use of BECA.

1.2 Project Partners

Coordination partners

empirica is a research and consulting firm based in Bonn, Germany, with a focus on innovation and research on new applications of information and communication technologies (ICTs) and their social and economic impact. www.empirica.com

Delphis is a professional non profit association grouping 21 non-profit companies that work in the field of social housing. These independent companies, active in some 16 regions, are the owner-managers of more than 160,000 high-rise or individual housing units, as well as building an average 2,000 new units per year. www.delphis-asso.org

The *Institute for Housing and Environment* (Institut Wohnen und Umwelt GmbH) is a research institution founded by the State of Hesse and the City of Darmstadt. Task of the institute is to research forms of housing and living conditions. www.iwu.de

Pilot sites and partners

Örebro (Sweden)

ÖrebroBostäder AB was founded in 1946 and now acts as the municipal housing company and largest landlord in Örebro. ÖrebroBostäder is pilot site manager in Örebro and co-operates locally with Örebro County Energy Agency and on the national level with the Swedish national Energy Authority and the public housing federation in Sweden, SABO.

Manresa (Spain)

FORUM is a municipal company (*FOMENT DE LA REHABILITACIÓ URBANA DE MANRESA, S.A.* - Promotion of the Urban Refurbishment of Manresa) established in 1994 aiming at promotion, programming, planning of and urban land management and urban rehabilitation within the municipality of Manresa. FORUM is responsible for the pilot site in Manresa.

CIMNE the International Centre for Numerical Methods in Engineering is an autonomous research and development centre dedicated to promoting and fostering advances in the development and application of numerical methods and computational techniques for the solution of engineering problems in an international context. The Buildings Energy and Environment (BEE) Group is an independent research group of around 15 people within CIMNE, focusing their R&D activities on methodologies and tools for the reduction of CO_2 emissions in the urban environment.

PICH AGUILERA ARCHITECTS is an architect company created in 1986. PICH works together with CIMNE in the pilot cluster in Manresa.

Darmstadt (Germany)

Bauverein AG Darmstadt was founded in 1864 as a housing company in public ownership. The main type of activities include rental management, housing and commercial estates, management of co-ownership properties, management of corporate premises, housing construction and condominiums for sale, conversion and redevelopment of quarters. The number of rental dwellings owned is around 18,000, the rental commercial estates about 280, plus approximately 5,000 parking spaces and five public buildings. Bauverein AG Darmstadt is pilot site manager for Darmstadt and leads work package work for pilot site preparation of the whole project.

Terchem is a leading global provider for the housing and property industry as well as for utilities in the fields of recording, allocating and billing data on energy, water and cooling consumption. Techem is the technology provider in the Darmstadt pilot site and leads technical management in the project.

Turin (Italy)

Agenzia Territoriale per la Casa della Provincia di Torino - ATC, was established in 1907 by the Torino City Council to supply underprivileged citizens with low-cost housing and at the same time administering and managing their own real estate and that entrusted to

them by other public bodies.

EXE.GESI.Spa has been established as an energy service company by ATC Torino in 2002 for building plants and heating management. EXE.GESI manages around 300 heating boilers and plants, and 1100 lifts, mainly in social housing stocks and provides planned and extraordinary maintenance of heating plants of ATC Torino (more than 700 buildings in the Province of Torino). Additionally EXE.GESI is involved in activities related to district heating, cogeneration and renewables.

Politecnico di Torino (POLITO) is a public research university dedicated to theoretical & applied research with 170,000 teaching hours per year, 26,000 students with 115 courses . The university research is organized in 18 departments and 12 service centres. POLITO has a strong reputation in research and education on sustainable technologies and renewable energies. With more than 800 research contracts with public institutions and industries worldwide, POLITO cooperates with various international research centres, industrial partners, local authorities and utilities.

Havirov (Czech Republic)

Mestska Realitni Agentura SRO (MRA) is a municipal real estate agency, founded on 1st January 1995 for the management and maintenance of the municipal housing stock. It is 100% owned by the Municipality of the city of Havirov. On the basis of a mandate contract MRA manages the municipal housing stock consisting of around 7767 apartments (in about 200 houses), 284 non-residential spaces (shops, offices), 13 ateliers, 67 garages and 21 individual objects (including 6 medical centres).

STÚ-K is a private consulting involved in national and international projects focused on housing, renovation of large panel buildings, energy efficiency, repairs of reinforced concrete structures, recycling of building materials and use of micro fillers in concrete mixtures and mortars. STÚ-K has been involved in several EU projects with special focus on IEE projects.

Ruse (Bulgaria)

Municipality Ruse is the fifth largest city of Bulgaria with approximately 170,000 inhabitants, located in the North-East of the country at the river of Danube. In BECA the municipality of Ruse involves the municipal owned company "Jilfond" that hosts and maintains the selected buildings, and works together with UniRuse and AMEA to set up the pilot site in Ruse.

The Association "Municipal Energy Agency - Ruse" (AMEA) activities focus on methodologies and tools for the reduction of CO2 emissions in the urban environment. Since 2001, AMEA has been involved in applied research for the energy retrofitting of municipal buildings, developing analysis methodologies and tools for the application of low energy concepts in the retrofitting of municipal buildings in Ruse.

Ruse University "Angel Kanchev" (UniRuse) works together with Ruse Municipality and AMEA in setting up the Bulgarian pilot site.

Belgrade (Serbia)

Belit Ltd. has considerable experience in the development and implementation of web-based information systems and portals and will collaborate with MEB, BeoElek and Palilula municipality in providing the ICT-based energy saving service the in Belgrade pilot site.

JKP Beogradske elektrane (BeoElek) is a Public Utility Company, which supplies heating and domestic hot water to Belgrade. The company was established in 1965 in order to centralise the Belgrade district heating system. BeoElek possesses 65 heat sources with 2.574 MW heating capacity. It provides heating to 300.000 apartments and more than 8,000 office/commercial buildings for the total floor area exceeding 20,200,000 square meters.

University of Belgrade - Faculty of Mechanical Engineering (MEB) has been involved in a number of projects in different areas, among which, energy, district heating systems, heat flow metering, fuels, RES, energy efficiency in buildings, combustion, household appliances, energy monitoring and environment. Project work of MEB builds upon recent activities in collaboration with local municipalities, such as the introduction of renewable heating energy sources, improved energy efficiency of buildings and improved environmental conditions in social housing districts.

1.3 The BECA solution

1.3.1 What is Smart Metering?

Like conventional meters, Smart Meters measure amounts of energy or water flowing through them. While conventional meters must be read manually, and the consumption calculated since the last reading, Smart Meters provide specific information on how much energy or water was consumed, when it was consumed and at what tariff – a continuous calculation that conventional meters are incapable of. Provided with detailed operational data the network operator is also able to decrease the cost to serve, by targeting investment in the network more accurately and thus maximising the benefits of system reinforcement. But Smart Metering offers more:

Digital technology: Smart Metering takes advantage of all the advances in modern digital technology; it enables data communication and can measure and deliver more information. More quantities and larger amounts of data can be stored until collected and meters can also be re-programmed or re-configured remotely.

Communications: Smart Metering enables long range communication with the energy company and short range links into the home. Consumption data can be read remotely and tariffs can be updated remotely. Smart Metering provides a communication gateway that functions as an interface between devices in the home and provides customers with real time data.

Control: Smart Metering allows for remote configuration and adjustment. This can be used in a number of ways, for instance, for supplier switching, remote reconfiguration of the meter as a credit or pay as you go meter, as the customer chooses to switch their supply contract. Finally, the meter can be used as the interface of a home automation network.

Better operation of networks: Smart Metering can greatly assist the network operator by providing detailed operating data from the ends of the network. Power quality can be measured by the meters and the network adjusted to improve its overall operation. Outages or leakages can be detected faster and system recovery monitored, minimising inconvenience to customers.

Exhibit 1 – Smart Metering service structure
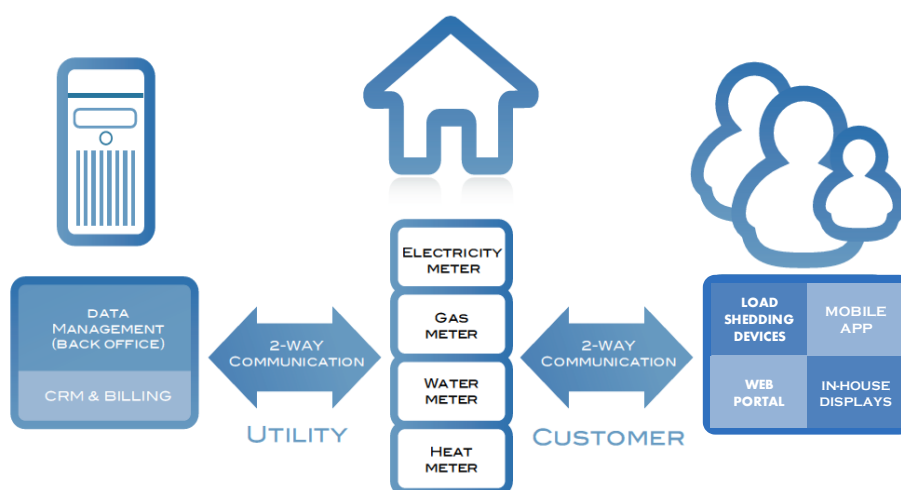
Adapted from ESMIG (2011) 'A Guide to Smart Metering – Empowering people for a better environment'.

Using these functionalities Smart Metering can support a whole range of new services. Many of these features are already available and in use for large commercial or industrial consumers. The

revolution in Smart Metering is seeing these features transferred to the residential and small commercial sectors with significant benefits to consumers, utilities, environment and society.

BECA presents a complementary set of viable and effective Resource Awareness and Resource Management Services, further described in this section. The approach is based on a modular "toolbox" of components that have been developed in the project, and from which housing providers and related stakeholders can select according to their own specific needs and the priorities of their strategy for energy efficiency.

BECA services include the following features:

- Automatic digital ("smart") metering for measuring electricity, heat, gas, water consumption;

- Non-invasive load monitoring to provide device-specific consumption data to tenants without per-device metering;

- Visualisation through analysis and presentation of consumption data for access by tenants on home displays, via the Internet and through other media;

- Simple "traffic light" feedback based on weather data adjusted comparison of heating consumption over time (historical feedback);

- Extension / modification of tenant portals in the Internet to present device-level information and meaningful trend information on energy use and add self management functions where appropriate;

- Optimisation and modification of invoicing and tariffs aligned with local legal requirements for allocating costs, particularly of heating and hot water, to building residents;

- Standards based in-building networks and gateways to transmit of consumption data in respect of electricity, gas, heating and hot water;

- Extension of schemes to provide network access to social housing buildings to channel metering information and give social housing tenants online access to consumption data and the wider internet;

- Monitoring the full energy delivery chain to identify investment priorities to optimise energy saving ROI in social housing;

- Aggregating and analysing data on energy use patterns in social housing across a region improve the targeting of public energy saving measures;

- Self-assessment scheme to assess the success of residents of a housing unit in reducing their energy consumption, including input of behavioural parameters by residents themselves;

- Automatic control (switching, dimming, adjusting operating parameters) of major domestic energy devices on timed signals with tariff incentives to even out the load and reduce peak demand with "fixed timing" defined by tariffs.

Two major service categories are distinguished: Resource Awareness Systems (RUAS), which provide tenants with greatly enhanced, timely feedback about their energy use, and Resource Management Systems (RMS), enabling end users (tenants), housing providers and/or energy providers to manage energy consumption in smart ways, leading to greater efficiency and lower GHG emissions.

1.3.2 Resource Awareness Systems (RUAS)

Advanced **Resource Awareness Systems (RUAS)** provide direct, timely and comprehensible feedback on energy consumption, enabling tenants to adapt their energy consumption behaviour.

An RUAS visualises energy (heating/cooling, electricity, sometimes also water) consumption in ways which are sufficiently user-friendly to attract tenants to explore their own data. Tenants have

access to RUAS through a web-based platform which allows them to quickly and easily obtain consumption information at monthly, daily or even shorter time-intervals. Online interaction should not, however, be the only way to approach users. Experience from real-world implementations shows that effectiveness can be increased markedly by combining online with offline modes of interaction.

Depending on the specific implementation context in a given country, city and building complex, a range of different approaches can be applied, as these examples from BECA pilot sites demonstrate:

Monitoring: A core element of the RUAS facing tenants is a web portal through which (close to) real-time monitoring of energy consumption is made possible. Via sensors installed in the dwelling measuring consumption of heating/cooling, electricity and/or water, data are collected, transferred to a data centre, processed for visualisation and then provided on the tenant portal. Presentation modes used for display on the portal are specific to each pilot site. In Örebro for example, tenants are presented with their monthly and annual consumption patterns in the form of technical units (e.g. kWh, m³), but estimates of the size of the respective bill in Swedish currency are indicated graphically.

Benchmarking: More specific kinds of information are provided through the online portal as well. One of the options available is benchmarking of energy consumption. Tenants are invited to compare their current consumption patterns to the data from earlier points in time or to data from reference groups, e.g. average over all dwellings in the same building. For example, in Karlsruhe tenants can compare their monthly consumption from one year to another, as the screenshot on the left shows. Visualisation through bar charts and statistics such as percentage decreases/increases are provided. **Peer comparisons** appear especially suited. This consists of comparison of household energy consumption levels between similar-sized households. This information may include neighbours within near vicinities or households of similar size. It enables participants to see if they use more or less electricity than their peers, without disclosing confidential data (averages rather than figures for individual neighbour dwellings are being used).

Personalised recommendations and advice: On the websites developed at BECA pilot sites, tenants have access to a personalised area after registering using their personal ID and password. Once in their private area, users are presented with recommendations and advice tailored to their individual consumption profile. This content is generated automatically. In Frankfurt, tenants receive advice through the website (for example, fully opening windows twice a day rather than leaving windows partly open all the day). Users can also download an app on their smart phone through which they are provided with forecasts of their monthly/annual consumption based on most recent data, in addition to a cost estimate. Thus, the application is able to warn the tenant that his bill might get out of hand if he would fail to alter his consumption scheme.

Alerts: In Catalonia, three levels of alerts have been developed. The first two ones are dedicated to the energy manager in order to react rapidly when a situation of data loss occurs and to be informed when a threshold is exceeded. The third kind of alert is dedicated to the tenant and is combined with adapted tips. When a situation which shows a non-adapted behaviour of the tenant is detected, the tenant is informed of the situation and an adapted tip is proposed to solve the problem. For example, a high heating consumption which is not combined with an increase of the inside temperature can show an abusive opening of the windows. It is advised to the tenant to close the window then.

Self Assessment: A self-assessment tool has been developed for use by tenants. The aim here is to let tenants set their own targets for energy savings to be achieved. Thus, they become active participants of the system rather than just receiving feedback on their energy consumption behaviour. At the BECA site in Catalonia, for example, pilot participants can pick a certain maximum consumption figure (in kWh or Euros) that they want to stay below by the end of the month. A straight line representing the target is automatically displayed in their personal consumption chart displayed online. Daily consumption figures are accumulated and displayed, making it possible for tenants to follow their performance in relation to their self-imposed targets.

Reports: Automatic generation of reports, which can be printed out or downloaded from the portal, has been welcomed by a large proportion of tenants. Reports provide general information on recent developments in energy matters, in addition to the main content made up of individual energy use data and a personalised analysis thereof.

Individual meetings / courses: At the BECA pilot site in Ruse (Bulgaria), a door-to-door approach enabled the project team to explain the system in face-to-face conversation with tenants. For this purpose the project team invited small groups of tenants, explained to them how to use the web portal and the tablet, and gathered feedback including open questions and requests. This approach proved very fruitful, as it appeared to make the innovation less mysterious and more open to user participation. Another objective was to identify and win over tenants who can take the role of ambassadors of the project, i.e. becoming promoters of the system and also transmitters of practical knowledge to those tenants who are hard to reach directly by the housing provider.

Energy Coach: Some BECA pilot sites made use of so-called energy coaches. The coach is to help tenants understand energy efficiency and how it relates to tenants' energy costs, and how these can be reduced most efficiently, making best use of the personalised feedback provided by the RUAS services. Activities of the coach include personal discussions; help with using the installed equipment and with the online portal; etc. The energy coach can be solicited by tenants themselves; she also pro-actively approaches tenants herself if there are indications/alerts or of the risk of fuel poverty, i.e. tenants showing difficulties to afford their monthly energy bill.

1.3.3 Resource Management Systems (RMS)

Resource Management Systems (RMS) provide services that enable a decrease of energy consumption based on automatic mechanisms. Smart meters measuring energy consumption in detail are an essential part of RMS. By providing real-time data about the amount of consumed energy and information about consumption time and seasons, smart meters enable system managers to monitor and control energy consumption and evaluate schemes to improve energy efficiency, while minimizing energy costs. RMS can respond to energy demand during peak consumption hours by defining energy saving schemes, such as reducing consumption of heating, ventilation, and air-conditioning systems and lighting or using electricity production systems on site.

As in the case of RUAS described above, a range of different approaches can be applied to exploiting the potential of smart meters and related ICTs to make energy management more efficient and effective. Below are some examples from BECA pilot sites:

Optimisation: The optimisation service is based on the measurement of key data in relation with the smooth functioning of the system. Temperatures, flows and different kinds of energy data are measured and transmitted to the property owner. Thus, the property owner has the possibility to analyse the performance of its systems and improve them. In Torino, the system analyses the data transmitted from the heating system and enables adjustments. This can then adapt the settings of its heating system by conveying these recommendations to the maintenance companies (for example, the expert may recommend to switch off the domestic hot water production system overnight, optimise the number of boilers or balance the hydraulic network according to the needs).

The optimisation service is also used at the dwelling level. Load management means that providers are able to offer their customers a contract allowing the energy company to remotely adjust the customer's load. For example, the energy company can remotely raise the set point for an air conditioning thermostat in the customer's property. Although the customer will not notice much difference, the net reduction in the load can be enough to keep reserve capacity at safe levels or even prevent a collapse of the system and reduce costs. The energy company can, in turn, pass these savings to the customer. Trials have shown that much of this reduction is sustainable.

The measurement of key data in the dwelling can be supervised and the property owner can intervene and change the parameters of the heating system or help the tenant to optimise his

energy consumptions. Besides, as is the case in some BECA pilot sites, the tenant himself can manage his devices thanks to specific devices or through the portal.

Early Default and Maintenance Management: The Energy Management Service can include a system of early default and maintenance management. The aim of this option is to take benefit of the service to carry out a surveillance of the systems and to be able to react and solve the problems more rapidly than before. For an example, see the screenshot on the right which is from the Darmstadt BECA site; it shows how the adapterm system works: If abnormal values are identified, they can easily be traced back to their point of origin allowing for quick countermeasures to be taken and / or the overall setting of the heating system to be optimised.
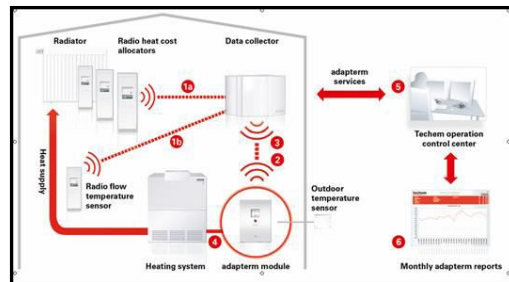
In Catalonia, the central solar system is equipped with a system of early default detection and maintenance management. If the production of the central solar system remains very low or is equal to 0 during three consecutive days, an email is automatically sent to the maintenance company as well as to the service provider. Thus, a revision of the system is possible and the problem can be solved within 3 days.

1.4 Stakeholder descriptions

This section identifies eight key stakeholders. In some constellations numerous roles could be played by one party. For instance, in some countries measurement of resource consumption is combined with the energy provision. Hence, the stakeholder definitions focus on the key function it plays in the implementation and operation of BECA services. Each party should check for any role it might play at any point of the project.

Social Housing Provider

The social housing provider is responsible for the buildings the tenants live in. This involves managing the facilities and organising - not necessarily performing - the billing of public space or publicly used commodities.

Local and City Councils

Local and city councils can be the provider of the social housing service. It might also be the party paying for resource consumption (and rent) of tenants receiving societal benefits and / or suffering from energy poverty. In some instances staff could also become a user of the service.

IT-Service Provider

The IT-service provider is responsible for collecting all data from the measurement service provider. This involves responsibility for the full process of the back-end data-stream and allowing tenants and social housing providers two-level access to their data.

Measurement Service Provider

The measurement service provider is responsible for collection of (smart) meter data and making the data of individual meters available to some other party. Usually, the measurement provider owns the meters and charges another party for meters and the services offered.

Energy Provider

The energy provider is the last distributor/agent of the commodity. The commodity sold to the tenant is used by the tenant himself. Usually, the energy provider either issues the bills directly to the tenant or through the social housing provider to the tenant.

Social Services

Social services in context of BECA focus in particular on social workers in touch with the tenants on regular basis. The relationship with the tenant can become a relevant entry point for empowering the tenant in conserving resources.

Tenant

The tenant lives in a single dwelling (or owns it) and is the user of the BECA service. Usually, he pays for the rent and all commodity bills but might also receive societal benefits.

2   Approach and Results

This chapter presents key results across all pilots and the life-time of the project and operation in particular. Each lesson learnt presented below results from one or more pilot sites whereby repetitions were summarised.

2.1   Lessons learnt structure

The structure of lessons learnt is orientated on business approaches to establish knowledge databases[1]. Any given lesson can be found by stakeholder addressed, category and whether it is a inhibiting or a facilitating factor. Any lesson learnt describes precisely which impact the issue has on the project and what measures should be taken to either avoid the problem or to ensure the success, respectively. The structure of the table is as follows:

- **Acronym** – The letter refers to the group and the groups follow the main stakeholders involved:
    - **T** – Tenants
    - **S** – Social housing provider
    - **I-M** – IT provider and Measurement provider – the two stakeholders are joined to avoid ambiguity and replication since the division of responsibilities tends to depend strongly on the local consortium
    - **E** – Energy provider
    - **C –** City administrations and social services

- **Category** – Categories are used for each individual lesson. They allow the reader to find all lessons with a certain focus across all stakeholders.

- **Issue** – Summarises the initial observation (cause) as a given fact.
    - Typically, a **challenge** is a difficulty encountered at any stage which could or could not be resolved during the life-time of the project;
    - A **facilitating factor** is an (often unexpected) achievement or situation which resulted in a positive impact on the success of the intervention.

- **Impact** – Summarises the effect(s) of the observation enabling the user to estimate the risk and cost / benefit of addressing the challenge or exploiting the facilitating factor, respectively.

- **Recommendation** – Summarises key measures that need to be taken in order to achieve success address challenges and overcome barriers.

In addition to the list below, the lessons will be incorporated as part of the '**Guide for replication**' (D8.4). In the Guide the lessons are not only put into context where and when they need to be considered but also reflected in extensive checklists and procedures which enable stakeholders to ensure that confusion can be avoided and potential problems be addressed effectively.

---

[1]   PMI (2013). A Guide to the Project Management Body of Knowledge, 5th Edition.

2.2 Lesson learnt – Social Housing providers

Note that in most cases, the housing company is likely to be manager of a project for implementation of BECA service. If others take the role of project manager, the lessons listed in this subchapter are of relevance for them as well.

Category	Issue	Impact	Recommendation
Partnership & buy-in	**S-1** Definition of roles and responsibilities of (sub) contractor / provider avoided conflict and cost.	➔ Hierarchies established avoid additional / unstructured communication ➔ Not allocated tasks, sometimes inducing costs, create conflicts between contractors and can bring work to an halt (potentially with knock-on effects) ➔ The effect was stronger where language barriers exist.	✔ Definitions of key stakeholders and their exact roles in the project must be outlined early on. ✔ Definitions should follow the role/function of the actor within the project, not the structure of the consortium. ✔ Each partner can play several roles, but potential role conflicts need to be identified and subsequently addressed at planning stage.
	S-2 Efforts to clearly allocate responsibility for addressing emerging issues paid off (contingency plans).	➔ Duplication of structures and processes were avoided. ➔ Technical or other problems in the implementation and operational phases were tackled without delays.	✔ Create a risk management table with all foreseeable issues and the process how they are to be dealt with (who, what, in which order). ✔ Make sure all stakeholders understand and agree to the risk management plan.
	S-3 Involve interest groups (e.g. Tenant's associations)	➔ In some countries, negotiations is required to agree upon fees. ➔ Non-inclusion might lead to negative image of service, especially in times of social media.	✔ Ensure transparency about targets and impact upon interest group ✔ Do not side-track regular parties ✔ Prepare proof for long-term
	S-4 Certain data might only be available at public authorities.	➔ In some countries only public utility companies are formally allowed to measure resource consumption ➔ Data collection is directly depending on the willingness of these public authorities to collaborate	✔ Involve the project representatives of public utility companies in the planning phase ✔ Establish agreements with the public utility companies prior to project start ✔ Consider adjustments providing additional benefits for the public utility.
	S-5 Energy / Measurement providers restricted or disallowed access to infrastructure installed at the site.	➔ To implement the service nevertheless, additional wiring or even metering equipment had to be installed. ➔ This added to cost and annoyed tenants.	✔ Contact and involve energy / measurement providers early on. ✔ Make sure that all key stakeholders perceive clear benefits from taking part in the project. ✔ Also check, however, whether contracts could be given to other providers in the future in case of non-

19/05/2014

Category	Issue	Impact	Recommendation
			compliance.
	S-6 Energy / measurement providers did (sometimes at short notice) restrict or disallow access to their past and / or current measurement recordings.	➔ Reduced possibilities to offer information services to users, such as time series comparisons. ➔ Lack of data for evaluation of the impacts of service implementation.	✓ Communicate early to secure buy-in; establish a legal agreement on how, when and which data are going to be shared
	S-7 Internal: Technician involvement	➔ 'Specialists' in (group of) buildings able to point out potential barriers for instalment ➔ Non-involvement: Caretakers and other maintenance staff complaint about additional workload ➔ Non-involvement: Responsibilities across departments were unclear and communication lead to new misunderstandings as old processes were disrupted	✓ Collect functional and non-functional requirements for system's implementation. ✓ Collect current inefficiencies to ensure new processes are capable of improving these ✓ Plan training to the service for the staff of the housing company
	S-8 Internal: Administration etc. involvement	➔ Staff aware of and understanding new service does not consider changes as threat or annoyance. ➔ Staff is able to communicate the service as it might reduce future workload	✓ Involve caretakers and other maintenance staff, e.g. through workshops / focus group meetings. ✓ Plan a short coach training to staff of the housing company
	S-9 Coordinate and integrate communal projects / goals aiming to increase energy efficiency, reducing CO_2 consumption etc.	➔ City administrations were actively and publically endorsing energy saving measures in public sector housing found it easier to obtain buy-in from all stakeholders. ➔ Joint development / production of materials / communication strategies reducing costs.	✓ Explore how the implementation fits the city's climate action strategy and (if applicable) local/ regional action plans for energy efficiency. ✓ From the outset, gain support from the city administration. For this, communicate how implementation can play a vital role in meeting the city's climate change policy goals. ✓ Investigate which other local stakeholders may be useful for joining together with to lobby for policy support (e.g. NGOs, unions, individual opinion-leaders).
Take-up and use	**S-10** Early announcement of BECA implementation raised interest and enabled all tenants to learn about the service.	➔ Announcing that an advanced energy service would be implemented made tenants curious and triggered early discussions about what is to come.	✓ Once the communication strategy has been finalised, create a large-scale poster for building facades announcing the service. Ensure content is generic so that it can be re-used in other estates. ✓ Also, include a news item on web-site and, if

Category	Issue	Impact	Recommendation
			applicable, magazine published by the company
	S-11 Video material to be used during introduction / exploitation of service	➔ Video platforms are on information channel as print materials are for others ➔ Further videos using similar format can also be used as training material. ➔ Helps to identify 'champions' and 'resisting user' who either can be targeted for further communication, respectively convincing of usefulness.	✓ Keep video under 5 minutes with interviews. ✓ Include interview with a user and show portal. ✓ Make use comment enabled platforms to engage exchange. ✓ Provide sharing features such as 'like'-buttons and twitter.
	S-12 Printed materials and open meetings are needed to inform users about service	➔ Depending on preferred information channel, paper materials remain the most important for some users. ➔ Open meetings help to create trust and transparency	✓ Make sure to have the necessary information brochures and guide materials before service operation start. ✓ Include a contact person in the brochures. ✓ If possible, organise group meetings with tenants for communicating and introducing them with the service before the operation start. ✓ Examine your tenants and split them into groups (e.g. the ones who prefer to receive information via phone, internet, paper, etc.)
	S-13 Inconsistent use of technical terms confused some users	➔ Some users voiced confusion when they felt that different terms were used for certain functionalities. ➔ Possibility that some users lost trust and/or interest as a result.	✓ Double-check all communication with tenants to make sure that service related terminology is used consistently.
	S-14 Identification and mobilisation of 'champions' in each group of tenants proved very beneficial for smooth implementation.	➔ Involving selected users as multipliers improved communication about the service. ➔ This way it helped boost numbers of users and willingness to adapt behavioural patterns of energy consumption.	✓ Identify users who have workable knowledge of heating and electricity systems (e.g. job experience) or are particularly interested in environmental issues. ✓ Give them additional training and involve them in planning. ✓ Consider equipping them with tablets and materials so that they can help neighbours.
	S-15 Choice and provision of Energy Coaches	➔ Energy Coaches teach users basic energy efficiencies knowledge and comprehensive use of the service not always existent. ➔ Users have opportunity to ask in person	✓ Organise fixed times and location for energy coach. ✓ Equip social workers with materials and basic knowledge to act as energy coaches capable of

Category	Issue	Impact	Recommendation
		➔ If users' profile in social environment is not taken into account, they might feel awkward about someone telling them what to do.	referring to experts. ✓ Enter the pilot site friendly **-** Choose carefully the people in charge to contact with tenants ✓ When appropriate, directly approach the heavy consumers detected in cases when you assess that there is no reasons for them to change their behaviour
	S-16 Barriers: It proved difficult to reach and motivate elderly tenants and those with low IT-literacy.	➔ Most of these types of tenants did not make use of the web-service and did, therefore, lack the information to reduce their energy consumption. ➔ Use of unnecessary technical jargon in communication of service deterred some users, especially elderly and immigrants.	✓ Provide paper-based excerpts which can be combined with standard billing. ✓ Increase billing frequency to once every month. ✓ Double-check all communication with tenants to make sure that no unnecessary technical jargon is used.
	S-17 Barriers: Not all users had sufficient access to the internet.	➔ Some users were excluded from using certain features of the service as these require (convenient) access to the internet	✓ Provide PC access points with internet access (kiosk) on the premises of or close to the site. The kiosks can be limited to service of social housing company (which could also be facilitated this way). It could allow access to popular websites such as news sites or social networks to attract tenants. ✓ Consider rolling out internet access to all tenants in parallel with introduction of service.
	S-18 The service targeting heating was scheduled to start just before heating season	➔ Minor delays at some pilot sites meant that here, savings achieved during the piloting phase were lower than what would have been possible.	✓ Make sure that services are ready to use at the start of the heating season, as this is the time when tenants are most open to suggestions for how to modify behaviour to achieve savings.
	S-19 Comparison with neighbours and historic data helped raise attention about the potential for savings and their impact.	➔ Tenants like simple graphs which clearly identify their current performance against the average of the house; some started private "competitions" about who could save most.	✓ Provide, as part of the dashboard on the tenant portal, simple comparisons across time and against averages. ✓ Avoid releasing data at dwelling level, however – use averages across buildings / groups of dwellings instead. Make sure there are more winners than losers since saving should never go below.
	S-20 In some cases, user interest in service declined after an initial stage of strong engagement.	➔ Number of logins on the web-service declined, making it less likely that tenants stay engaged to reduce their energy consumption.	✓ Provision of factual information through smart meters alone will not suffice. Design a long-term strategy for user engagement, including continuous interaction with tenants through a mixture of

Category	Issue	Impact	Recommendation
			communication channels.
	S-21 When information was published simultaneously through different communication channels, it proved to be much more effective.	➜ Tenants who were informed through numerous communication channels were found more often to be aware of solution and its functionalities.	✓ Set dates when news items are to be communicated through all available channels. Select dates close to the start of operation to build and maintain momentum.
	S-22 Careful placement of promotional information helped with communication.	➜ Sites in which announcement were published in the entry area using posters or notifications had, on average, a higher share of tenants visiting the online portal.	✓ Consider installing notification board in a public area (e.g. entry hall, staircase, lift) on which relevant news are being pinned on as posters or sheets of paper.
	S-23 Surveys provide user experience helping to set priorities for future developments.	➜ Surveys are source of ideas on how to improve the service from tenants' perspective ➜ Users learn they can contribute or already contributed in further improving the solution	✓ Plan / organise two surveys with users before and after service implementation ✓ Include interviews of selected tenants and / or professionals ✓ Limit the number of questions. ✓ Communicate changes triggered by survey to ensure future participation.
Data privacy & security	**S-24** Survey question can upset users	➜ Questions regarding (energy) subsidies upset tenants and trigger them to complain about survey wrongly associating it with the service.	✓ Verify questionnaires with small set of tenants or tenant's association. ✓ Clearly communicate that surveys are anonymous.
	S-25 Some tenants expressed concerns regarding data privacy.	➜ A number of users declined to sign the data protection agreement, although they were initially interested in the service. ➜ They could therefore not participate in the programme, reducing total savings.	✓ Pro-active communication is a must. Provide an info sheet explaining risks for and rights of tenants using simple language. ✓ In case of signs of concern about the topic, consider involving an independent data privacy/ security expert in project (e.g. consumer advocate). ✓ PR activities should emphasise the efforts being taken to protect data privacy.
	S-26 Social workers proved good in communicating the objectives of energy campaigns, and in engaging tenants to take up the service.	➜ Users welcomed advice coming from individuals such as social workers whom they trust to operate in their interest, who stress the economic benefits of energy saving, and who "speak their language".	✓ From the outset involve social services in the project – individuals who have a relationship with users are more likely to be listened to.
Technical	**S-27** Tenant involvement during service design proved to be vital	➜ Focus group meetings with tenants helped to identify which service features are most likely to be	✓ Organise tenants to focus group meetings during the preparatory stage of the project. Also invite the

Category	Issue	Impact	Recommendation
set-up	for the success of implementation.	successful. ➔ They also helped to find 'champions' who later acted as multipliers in the project.	staff who is going to be involved in operating and communicating the services.
	S-28 Maintenance staff involvement in service design proved to be very useful for use case definition and subsequent roll-out.	➔ Caretakers and other maintenance staff contributed to specifics of buildings and systems installed. ➔ This helped improve the efficiency of certain functionalities and accuracy of use case definition.	✓ When designing the architecture at the given estate, involve maintenance staff (e.g. via focus group meetings). Ask staff which action they would take and explain early on what the system will be able to do.
	S-29 Collaboration between partners involved in technical implementation is markedly better when use cases were agreed upon beforehand, using a common, and fully adequate description format.	➔ Agreement upon use cases reduced the number of technical difficulties and helped to add further innovation	✓ Web-service provider should design (simplified) UML use cases of all relevant functionalities for tenants, staff and automated systems. ✓ In a technical meeting agree which use cases are relevant and whether all steps can be handled by the parties involved.
	S-30 Designing one process model per use case helped to reduce the potential for misunderstandings.	➔ Having one process model per use case meant that all steps were always visible for all parties, as the result of which changes could be more easily agreed upon.	✓ For each use case, design one process model which covers all steps for all stakeholders. Within each step, decisions about design can remain in the hand of the developing / contributing party and do not need to be disclosed.
	S-31 Standardised use cases and process models helped reduce potential for misunderstandings.	➔ Staff with limited IT-knowledge benefited from conceptualised representations by which functionalities could be chosen from a "menu" and single steps be altered and deleted	✓ Provide a "menu" of all functionalities supported by your software and relevant for the pilot. First select the use cases to be installed (ideally a simplified UML); use as little technical jargon as possible.
	S-32 Since smart phones were not considered standard at the beginning of the project, service was not designed to be accessed by these (now commonplace) end devices.	➔ Some sites have yet no smart phone application since the focus was on web-services. Some web-services are not optimised for smaller screens	✓ Ensure the service can be extended to use other media by providing standardised data bases and open data protocols as formats that are going to be used in future end devices cannot be anticipated. ✓ Investigate technical trends which are likely to have a direct bearing on the implementation.
	S-33 Service implementation benefits from public Wi-Fi infrastructure	➔ Where all tenants had free access to the internet through a public Wi-Fi, they were making more use of the energy portal. ➔ The RUAS can be used as a means to attract tenants to develop their digital literacy skills.	✓ Explore possibilities for providing tenants with free internet access, e.g. through a public Wi-Fi infrastructure. ✓ One option can be to join together with other social housing companies and lobby local government for set-up of a public Wi-Fi network.

Category	Issue	Impact	Recommendation
Outcomes	**S-34** Implementation of management systems lead immediately to the detection of major problems affecting energy efficiency of the building stock.	→ Considerable savings in energy. → Enthusiastic response from building / energy managers. → Investments in RMS paid off over a short period of time.	✓ Use RMS to obtain immediate, sustained savings by detecting and abolishing malfunctioning systems and sources of energy loss.
	S-35 Monitoring heat production proved to be essential for reduction of energy consumption.	→ Management services (RMS) monitoring heat production sites (especially centralised systems) helped detect defaults sooner → This enabled the swift elimination of inefficiencies and wastage.	✓ Install management systems first to ensure catching the "easy wins" and herewith collecting funds for further installations. ✓ Consider automated alarms. ✓ Train staff properly to use the RMS for detection of problems. Include training measures in the budget for RMS implementation.
	S-36 Effects of using management system was better if access to the system was given to maintenance staff as well.	→ Offering other technical and maintenance staff access to the RMS lead to detection of defaults in the existing infrastructure which had caused inefficiencies.	✓ Provide (restricted) accounts to all staff and suggest any checks they could do remotely rather than in person. This enables better monitoring of more buildings at the same time.
	S-37 Practical hints on how to reduce energy use lead directly to changes in tenant behaviour.	→ Clear evidence of changes in behaviour caused by practical advice given, resulting in lower energy consumption and utility bills	✓ The more practical and easily applicable recommendations to tenants are, the easier it will be for users to modify their behaviour. ✓ Make smart use of the online tenant interface to provide energy advice (in bite-sized formats) to tenants.
	S-38 ICT monitoring identified issues with Solar Thermal System	→ Due to the temperature settings of the centralised system, the fraction which ST provided energy was detected to be lower than expected. → After an adjustment of these settings, an important increase of the ST provided energy was achieved.	✓ Implement a monitoring system for renewables. ✓ Integrate alerts into ICT-solution ✓ Check the impact(s) of any new implemented settings, easier and cheaper with RMS.
	S-39 Communication campaigns benefit from the use of evidence collected at the same site.	→ Tenants at various sites welcomed BECA implementation especially because of its ability to provide immediate, quantitative evidence of the results of energy saving measures. → Communication of aggregate savings, e.g. across the entire building stock, appeared to work well in promotional efforts.	✓ Any communication campaign recommending methods to reduce energy consumption should also provide means by which the success of the citizen's effort can be measured. ✓ Make evaluation a core part of the implementation work plan. Make sure that evidence of energy savings is gathered as soon after the project start as

Category	Issue	Impact	Recommendation
			possible, and use it for subsequent information and promotion activities.
	S-40 Internal resources / cost for billing can be saved / reduced.	➔ Service enabled housing provider to organise billing by themselves instead of contracting it to more expensive party. ➔ Time spent on complaint procedures could be cut as evidence for billing and on-going consumption was integrated while being accessible to tenants.	✓ Coordinate with financial department to ensure data created allows for billing procedures. ✓ Coach administrative stuff how to use service in order to quickly check upon evidence during calls. ✓ Make it easy for tenants to contact responsible at billing department by providing details for – ideally - personalised contact to close complaint case with first occurrence.
	S-41 In environments with, already, low consumption BECA is tool for detecting wastage, not additional savings.	➔ If saving the focus, user consider not needing the service and therefore do not benefit from other features. ➔ Wastages is only detected with next bill.	✓ Check whether consumption levels – given the local environment – are low or high. ✓ Adjust focus of materials and communication accordingly.

2.3   Lesson learnt – Tenants

Recommendations in this subsection are targeted at representatives of tenants rather than individuals.

Category	Issue	Impact	Recommendation
Partnership & buy-in	**T-1** At pilot sites where there is a history of initiatives around energy saving, smart meter technologies were particularly welcomed by tenants.	➔ Strong interest among tenants, high rates of uptake. ➔ Low average levels of energy consumption per dwelling, inhabitant and square meter.	✓ Implementation should not take place as stand-alone measure, but embedded in long-term, continued activities for raising awareness about energy efficiency. ✓ Request information on the long-term strategy for energy efficiency of the housing company and energy provider.
	T-2 Tenant involvement during service design proved to be vital for the success of implementation.	➔ Focus group meetings with tenants helped to identify which service features are most likely to be successful. ➔ Serious involvement in the project from an early stage onwards made it easier to obtain buy-in also from sceptical tenants.	✓ Ask for meetings already at preparatory stage to gain a full understanding of the programme and to discuss open issues. ✓ Request that a representative of the tenant association participates in meetings.
Take-up and use	**T-3** Organised workshops and trainings resulted helpful in improving tenants' ICT knowledge.	➔ After training greater number of users begin to use portal ➔Users with difficulties in using IT technologies were grateful for organised workshops ➔ Users felt certain responsibility to participate in other project activities	✓ Assess your users' background and organise training / workshop sessions for tenants lacking ICT knowledge. ✓ Provide tenants with energy coaching and continuously contact tenants' representatives.
	T-4 Personalised energy advice proved effective in helping tenants adapt their behaviour.	➔ Reduced energy consumption ➔ Smaller utility bills ➔ Way to prevent fuel poverty ➔ Increased motivation to use the service and change consumption behaviour	✓ Request practical advice that can effectively help reduce energy consumption. ✓ Use of data on automatically detected patterns of consumption should only be made when the tenants opts for it (opt-in). ✓ Improve your guidelines. Provide estimation on how much energy can be saved by taken measures.
	T-5 Complexity of graphs used	➔ Users fail to understand graphs shown on default if to many colours / contexts. ➔ Users fail to comprehend adjustments of periods and the effects upon the graphs.	✓ Reduce number of options to the bare minimum ✓ Ensure simplicity of language used as much as consistency (e.g. location of graphs) across resources. ✓ Provide an expert section for users with more

			interest
	T-6 Not all tenants had sufficient access to the internet / sufficient ICT equipment.	➔ Some tenants were excluded from using certain features of the service as these require (convenient) access to the internet	✔ Request that all tenants have access to the benefits to be derived from implementation, as far as possible. ✔ Request schemes for rolling out internet access to all tenants in parallel with introduction of service. ✔ Request PC access points with internet access (kiosk) on the premises of or close to the site. The kiosks can be limited services of the social housing company (which could also be facilitated this way). It could allow access to popular websites such as news sites or social networks to attract tenants
	T-7 It proved difficult to reach and motivate elderly tenants and those with low IT-literacy.	➔ Most of these types of tenants did not make use of the web-service and did, therefore, lack the information to reduce their energy consumption. ➔ Use of unnecessary technical jargon in communication of BECA services deterred some tenants, especially elderly and immigrants.	✔ Request that feedback is also supplied in paper-based format (possibly combined with monthly bill) to make sure that all tenants are reached. ✔ Prepare brochures on know-how about web portal ✔ Request that bills are easy enough to understand by all tenants, including immigrants.
	T-8 Face-to-face meeting with users	➔ Help achieving positive results during user recruitment, after joint meetings have been organised and informational and educational materials have been distributed ➔Makes possible to get full picture about real situation and potential barriers	✔ Talk to people in person by organising face-to-face meetings even though it might require some time efforts. ✔ Pay them personal attention and make tenants continuously feel part of the project.
Data privacy & security	**T-9** Some tenants expressed concerns regarding data privacy.	➔ A number of tenants declined to sign the data protection agreement, as they were concerned about data privacy. ➔ They could therefore not participate in the programme, i.e. not benefit from the savings enabled by the system.	✔ Request that comprehensive and clear information is given about data privacy and security issues, and that adequate measures are taken to prevent mishandling of data and security breaches. ✔ Ask for involvement of an independent data privacy/ security expert in project (e.g. consumer advocate).
	T-10 Social workers proved good in communicating the objectives of energy campaigns, and in engaging tenants to take up the service.	➔ Tenants welcomed advice coming from individuals such as social workers whom they trust to operate in their interest, who stress the economic benefits of energy saving, and who "speak their language".	✔ Press for involvement of trusted "middlemen" such as social services workers and representatives of tenants associations to make sure your interests are properly reflected in the implementation process.

Technical set-up	**T-11** Providing tenants with BECA services via digital TV brought a number of advantages, including frequent display of energy related data to users and high acceptance among users.	→ Frequent display of up-to-date energy consumption data to users through their TV set: Once every day the smart box would reset the channel and open the BECA dashboard when the TV is turned on. → Positive response from users in spite of pro-active communication of consumption data.	✓ Request that the feedback on consumption behaviour is being provided in ways which make best use of existing infrastructure, e.g. end devices (TV sets, smart phones), rather than adding new devices to the dwelling. ✓ Make sure that you know what to do in case of end devices or other technology not working properly.
	T-12 Paper based manual for and technical support via phone.	→ Users are not willing / able to read a lot of information → Technical support via phone helped to provide users with necessary information.	✓ Besides the paper based manual, also provide technical support by phone. ✓ Set up a centralised hotline across various departments
Outcomes	**T-13** Automated temperature settings lead to reduced wastage.	→ Limiting the provision temperature to a set temperature (e.g. 21°C) lead to savings in energy consumption since tenants were kept from regulating temperature by opening windows. → The pilot experience does *not* indicate that acceptance by tenants will be a serious problem.	✓ If the maximum temperature in dwellings is regulated this way, make sure that the actual temperature delivered is as high as promised. ✓ Request that the system still allows for supplying (selected) users with the option to regulate the temperature through a home display or similar.
	T-14 RUAS offers much enhanced possibilities for peak shaving.	→ Dwellings heated by electricity were used successfully to regulate predicted peaks by reducing heat production during peak times. → Substantial peak-shaving realised.	✓ Tenants should benefit as well from the energy savings generated via peak shaving. Request some kind of compensation, e.g. vouchers or discounts.
	T-15 Practical hints on how to reduce energy use lead directly to changes in tenant behaviour.	→ Clear evidence of changes in behaviour caused by practical advice given, resulting in lower energy consumption and utility bills	✓ Request that advice is given in the form of practical and easily applicable recommendations. ✓ Request that smart use is being made of the online tenant interface to obtain energy advice, possibly also on-demand.
	T-16 Frequency of automated warning	→ Receiving the same alert for several weeks will lead to considering any message as useless. → Professionals, in particular, require being pointed real issues and heavy consumers.	✓ Implement procedure to avoid sending same alert over again (e.g. surpass or propose change via direct link) ✓ Messages and recommendations need to change frequently in order to capture attention and involve actions.

2.4 Lesson learnt – IT / Measurement Providers

Category	Issue	Impact	Recommendation
Partnership & buy-in	**I-M-1** Some measurement providers collaborated only tentatively with the project, as they did not perceive significant benefits from involvement.	➔ In some cases, measurement providers restricted or disallowed access to infrastructure installed at the site. ➔ Also, some measurement providers did (sometimes at short notice) restrict or disallow access to past or current measurement recordings.	✓ Measurement providers that have not done so already should devise a long-term strategy how to deal with smart meter-based energy efficiency projects, as there is the risk that they will otherwise be seen as inhibiting factor that should in the longer term be bypassed, i.e. removed from the value chain. ✓ If necessary, set conditions (such as financial compensation for access to data or infrastructure) for active involvement in the implementation project.
	I-M-2 Some energy providers restricted or disallowed access to infrastructure installed at the site.	➔ To implement the service nevertheless, additional wiring or even metering equipment had to be installed. ➔ This added to cost and annoyed tenants.	✓ Contact and involve energy / measurement providers early on. ✓ Make sure that all key stakeholders perceive clear benefits from taking part in the project. ✓ Also check, however, whether contracts could be given to other providers in the future in case of non-compliance.
	I-M-3 Some energy providers did (sometimes at short notice) restrict or disallow access to their past and / or current measurement recordings.	➔ Reduced possibilities to offer information services to users, such as time series comparisons. ➔ Lack of data for evaluation of the impacts of BECA implementation.	✓ Communicate early to secure buy-in; establish a legal agreement on how, when and which data are going to be shared
	I-M-4 After installation, it is important that all meters are tested and evaluated before starting with system operation	➔ Any potential malfunction or error can damage the credibility of the system.	✓ Implement standardise testing procedure.
Take-up and use	**I-M-5** Well-designed online portals help raising interest among young and tech-savvy tenants.	➔ Children and young adults positively welcomed certain features of the online portal, spending more time on BECA and often communicating experiences to relatives	✓ Make sure that the service runs on (new) media devices such as game consoles; provide material such as comics or characters appealing to children even if they are not (yet) the immediate target audience.
	I-M-6 Offering the energy portal as part of a smart home application	➔ Rather than working as stand-alone applications, at some sites the portal and energy management	✓ Consider services as an entry point for cloud-based services which go beyond mere metering

Category	Issue	Impact	Recommendation
	helps raise tenants' interest.	apps were combined with smart home features into a control centre for the home. ➔ This made the system more desirable in the eyes of many tenants.	services and include home control features which, in turn, can help keep users interested and exposed to energy-saving related information
	I-M-7 Not all tenants had sufficient access to the internet.	➔ Some tenants were excluded from using certain features of the service as these require (convenient) access to the internet	✔ Assess, at an early stage during the preparatory stage, spread of internet access and uptake in your target group, e.g. using a questionnaire survey (a random sample may be sufficient). ✔ Provide PC access points with internet access (kiosk) on the premises of or close to the site. The kiosks can be limited to BECA and services of the social housing company (which could also be facilitated this way). It could allow access to popular websites such as news sites or social networks to attract tenants. ✔ Consider schemes for rolling out internet access to all tenants in parallel with introduction of BECA. This may require funding from external sources (e.g. network provider).
	I-M-8 It proved difficult to reach and motivate elderly tenants and those with low IT-literacy.	➔ Most of these types of tenants did not make use of the web-service and did, therefore, lack the information to reduce their energy consumption.	✔ Check all interfaces and online services for accessibility using the latest standards, e.g. Web Content Accessibility Guidelines[2]. ✔ Check all promotional and communication materials for use of clear and plain language.
Data privacy & security	**I-M-9** Some tenants expressed concerns regarding data privacy.	➔ A number of tenants declined to sign the data protection agreement, although they were initially interested in the service. ➔ They could therefore not participate in the programme, reducing total savings.	✔ During the design and implementation phases, check all services to make sure that personal data are treated according to accepted data privacy standards. ✔ In the case that users can be expected to have concerns about this issue, consider involving an independent data privacy/ security expert in project (e.g. consumer advocate). ✔ If appropriate, develop versions of the services

---

[2] See http://www.w3.org/WAI/

Category	Issue	Impact	Recommendation
			which collect less data (even if this would limit functionalities), to be prepared for the case that the preferred solution cannot be implemented because of tenant opposition.
Technical set-up	**I-M-10** Tenant involvement during service design proved to be vital for the success of implementation.	➔ Focus group meetings with tenants helped to identify which service features are most likely to be successful. ➔ They also helped to find 'champions' who later acted as multipliers in the project.	✓ Organise tenants to focus group meetings during the preparatory stage of the project. Also invite the staff who are going to be involved in operating and communicating the services.
	I-M-11 Since smart phones were not considered standard at the beginning of the project, BECA services were not (in all cases) designed to be accessed by these (now commonplace) end devices.	➔ Some sites have yet no smart phone application since the focus was on web-services. Some web-services are not optimised for smaller screens	✓ Ensure the service can be extended to use other media by providing standardised data bases and open data protocols as formats that are going to be used in future end devices cannot be anticipated. ✓ Investigate technical trends which are likely to have a direct bearing on the implementation.
	I-M-12 Implementation benefits from public Wi-Fi infrastructure	➔ Where all tenants had free access to the internet through a public Wi-Fi, they were making more use of the energy portal. ➔ Service can be used as a means to attract tenants to develop their digital literacy skills.	✓ Explore possibilities for providing tenants with free internet access, e.g. through a public Wi-Fi infrastructure. ✓ One option can be to join together with other social housing companies and lobby local government for set-up of a public Wi-Fi network.
	I-M-13 Providing users with service via digital TV brought a number of advantages, including frequent display of energy related data to users and high acceptance among users.	➔ Frequent display of up-to-date energy consumption data to users through their TV set: Once every day the smart box would reset the channel and open dashboard when the TV is turned on. ➔ Positive response from users in spite of pro-active communication of consumption data.	✓ Implement support of smart TVs (for instance, how to install set-top boxes); design a one-page dashboard optimised for large screens. ✓ Include information of daily interest – such as local temperature or traffic information – to keep users from switching channels before they can take in the information. ✓ Set dashboard to a simple channel (e.g. 88) which cannot be changed; this will make it easier to refer to the service for promotional purposes.
	I-M-14 Equipment across dwellings and its documentation is not necessarily up-to-date	➔ In case the issue is not discovered / resolved on time, delays in any of the project tasks may be caused. ➔ Project performance might be at risk	✓ Carefully check the documentation validity before you start implementing the service. ✓ Consult with building professionals for resource distribution systems within the buildings

Category	Issue	Impact	Recommendation
	I-M-15 Many M-BUS gateways do not allow for reading measurements programmatically via a documented API, but only via a fixed-purpose software	➜ Selecting equipment requires effort ➜ It is hard to pair devices and protocols because of the lack of industrial approved standards. ➜ Implementation of systems requires additional verification.	✓ Set a clear list of requirements against which equipment is tested ✓ Test selected equipment on smaller scale ✓ Lobby on European level for suitable and robust protocol as a standard.
	I-M-16 Retrofitting measures: Specification of equipment	➜ Economic savings are achieved if appropriate equipment for each site is defined before starting the retrofitting project ➜ Resource savings achieved if, for instance, batters changes can be avoided	✓ Check which measures are to be taken during retrofitting ✓ Cross check the impact of a software technology and the hardware retrofitting impact. The latter can be reduced if a good ICT tool is efficiently implemented
Outcomes	**I-M-17** Effects of using management system was better if access to the system was given to maintenance staff as well.	➜ Offering other technical and maintenance staff access to the RMS lead to detection of defaults in the existing infrastructure which had caused inefficiencies.	✓ Design the RMS to allow for limited access by different types of staff so that as many practitioners as possible can be involved in detecting problems and developing solutions concerning energy management of the building stock.
	I-M-18 Monitoring heat production proved to be essential for reduction of energy consumption.	➜ Management services monitoring heat production sites (especially centralised systems) helped detect defaults sooner ➜ This enabled the swift elimination of inefficiencies and wastage.	✓ Install management systems first to ensure catching the "easy wins" and herewith collecting funds for further installations. ✓ Consider automated alarms. ✓ Communicate to building manager that they need to train their staff properly to use the RMS for detection of problems. Include training measures in your calculation for budgeting RMS implementation.
	I-M-19 Practical hints on how to reduce energy use lead directly to changes in tenant behaviour.	➜ Clear evidence of changes in behaviour caused by practical advice given, resulting in lower energy consumption and utility bills	✓ The more practical and easily applicable recommendations to tenants are, the easier it will be for users to modify their behaviour. ✓ Design the online tenant interface in a way which facilitates effective provision of energy advice (in bite-sized formats) to tenants.
	I-M-20 Communication campaigns benefit from the use of evidence collected at the same site.	➜ Tenants at various sites welcomed BECA implementation especially because of its ability to provide immediate, quantitative evidence of the results of energy saving measures. ➜ Communication of aggregate savings, e.g. across	✓ Design the service in a way which allows continuous collection of aggregate data on savings. ✓ Make sure that evidence of energy savings is gathered as soon after the project start as possible, and use it for subsequent information and promotion

Category	Issue	Impact	Recommendation
		the entire building stock, appeared to work well in promotional efforts.	activities.
	I-M-21 A greater interaction of public utility companies with tenants is needed	➔ A higher involvement of public utility companies in relations with tenants would provide a better level of understanding between public utility companies and tenants ➔ Users' level of confidence with regard to the offered service will increase	✓ Involve public utility companies in every aspect that concerns them and their consumers.

2.5   Lesson learnt – Energy providers

Category	Issue	Impact	Recommendation
Partnership & buy-in	**E-1** Some energy providers collaborated only tentatively with the project as they did not perceive significant benefits from involvement.	➔ In some cases, energy providers restricted or disallowed access to infrastructure installed at the site. ➔ Also, some energy providers did (sometimes at short notice) restrict or disallow access to past or current measurement data.	✔ Stakeholders measuring data that have not done so already should devise a long-term strategy how to deal with smart meter-based energy efficiency projects, as there is the risk that they will otherwise be seen as inhibiting factor that should in the longer term be bypassed, i.e. removed from the value chain. ✔ If necessary, set conditions (such as financial compensation for access to data or infrastructure) for active involvement in the implementation project.
	E-2 Some energy providers restricted or disallowed access to infrastructure installed at the site.	➔ To implement the service nevertheless, additional wiring or even metering equipment had to be installed. ➔ This added to cost and annoyed tenants.	✔ Contact and involve energy providers early on (if applicable).
	E-3 Some measurement providers did (sometimes at short notice) restrict or disallow access to their past and / or current measurement recordings.	➔ Reduced possibilities to offer information services to users, such as time series comparisons. ➔ Lack of data for evaluation of the impacts of BECA implementation.	✔ Communicate early to secure buy-in. ✔ Establish a legal agreement on how, when and which data are going to be shared.
Take-up and use	**E-4** In some cases, tenant interest in BECA services declined after an initial stage of strong engagement.	➔ Number of logins on the web-service declined, making it less likely that tenants stay engaged in efforts to reduce their energy consumption.	✔ Provision of factual information through smart meters alone will not suffice. There is a need for a long-term strategy for user engagement, including continuous interaction with tenants through a mixture of communication channels.
	E-5 The service targeting heating was scheduled to start just before heating season	➔ Minor delays at some pilot sites meant that here, savings achieved during the piloting phase were lower than what would have been possible.	✔ Make sure that services are ready to use at the start of the heating season, as this is the time when tenants are most open to suggestions for how to modify behaviour to achieve savings.
	E-6 Comparison with neighbours and historic data helped raise attention about the potential for savings and their impact.	➔ Tenants said they liked simple graphs which clearly identify their current performance against the average of the house; some started private "competitions" about who could save most.	✔ Provide, as part of the dashboard on the tenant portal, simple comparisons across time and against averages. ✔ Avoid releasing data at dwelling level, however – use averages across buildings / groups of dwellings

Category	Issue	Impact	Recommendation
			instead. Make sure there are more winners than losers since saving should never go below.
	E-7 It proved difficult to reach and motivate elderly tenants and those with low IT-literacy.	➔ Most of these types of tenants did not make use of the web-service and did, therefore, lack the information to reduce their energy consumption. ➔ Use of unnecessary technical jargon in communication of BECA service deterred some tenants, especially elderly and immigrants.	✓ Provide paper-based excerpts which can be combined with standard billing. ✓ Increase billing frequency to once every month. ✓ Involve a communication specialist to adapt the design and language of the printed bill so that it is attractive to read and easy to understand by everybody.
Data privacy & security	E-8 Some tenants expressed concerns regarding data privacy.	➔ A number of tenants declined to sign the data protection agreement, although they were initially interested in the service. ➔ They could therefore not participate in the programme, reducing total savings.	✓ During the design and implementation phases, check all services to make sure that personal data are treated according to accepted data privacy standards. ✓ In the case that users can be expected to have concerns about this issue, consider involving an independent data privacy/ security expert in project (e.g. consumer advocate).
Technical set-up	E-9 Tenant involvement during service design proved to be vital for the success of implementation.	➔ Focus group meetings with tenants helped to identify which service features are most likely to be successful. ➔ They also helped to find 'champions' who later acted as multipliers in the project.	✓ Organise tenants to focus group meetings during the preparatory stage of the project. Also invite the staff who are going to be involved in operating and communicating the services.
	E-10 Maintenance staff involvement in service design proved to be very useful for use case definition and subsequent roll-out.	➔ Caretakers and other maintenance staff contributed to specifics of buildings and systems installed. ➔ This helped improve the efficiency of certain functionalities and accuracy of use case definition.	✓ When designing the architecture at the given estate, involve maintenance staff (e.g. via focus group meetings). Ask staff which action they would take and explain early on what the system will be able to do.
	E-11 BECA implementation benefits from public Wi-Fi infrastructure	➔ Where all tenants had free access to the internet through a public Wi-Fi, they were making more use of the BECA energy portal. ➔ The RUAS can be used as a means to attract tenants to develop their digital literacy skills.	✓ Explore possibilities for providing tenants with free internet access, e.g. through a public Wi-Fi infrastructure. ✓ One option can be to join together with other social housing companies and lobby local government for set-up of a public Wi-Fi network.
Outcomes	E-12 Automated temperature	➔ Limiting the provision temperature to a set	✓ Implement a feature which can set a maximum

Category	Issue	Impact	Recommendation
	settings lead to reduced wastage	temperature (e.g. 21°C) lead to savings in energy consumption since tenants were kept from regulating temperature by opening windows. ➔ The pilot experience does *not* indicate that acceptance by tenants will be a serious problem.	temperature up to which supply of heating is guaranteed. ✔ Make sure the system still allows for supplying (selected) users with the option to regulate the temperature through a home display or similar.
	E-13 RUAS offers much enhanced possibilities for peak shaving	➔ Dwellings heated by electricity were used successfully to regulate predicted peaks by 'storing heat' and reducing heat production during peak times. ➔ Substantial peak-shaving realised.	✔ Estimate costs of peak times and contact housing companies to use estates as "virtual batteries". ✔ To offset any perceived loss of comfort due to peak-shaving, consider offering tenants some kind of compensation, e.g. vouchers or discounts.
	E-14 Monitoring heat production proved to be essential for reduction of energy consumption.	➔ Management services (RMS) monitoring heat production sites (especially centralised systems) helped detect defaults sooner ➔ This enabled the swift elimination of inefficiencies and wastage.	✔ Install management systems first to ensure catching the "easy wins" and herewith collecting funds for further installations. ✔ Consider automated alarms. ✔ Train staff properly to use the RMS for detection of problems. Include training measures in the budget for RMS implementation.
	E-15 Communication campaigns benefit from the use of evidence collected at the same site.	➔ Tenants at various sites welcomed BECA implementation especially because of its ability to provide immediate, quantitative evidence of the results of energy saving measures. ➔ Communication of aggregate savings, e.g. across the entire building stock, appeared to work well in promotional efforts.	✔ Any communication campaign recommending methods to reduce energy consumption should also provide means by which the success of the citizen's effort can be measured. ✔ Make evaluation a core part of the implementation work plan. Make sure that evidence of energy savings is gathered as soon after the project start as possible, and use it for subsequent information and promotion activities.
	E-16 Practical hints on how to reduce energy use lead directly to changes in tenant behaviour.	➔ Clear evidence of changes in behaviour caused by practical advice given, resulting in lower energy consumption and utility bills	✔ The more practical and easily applicable recommendations to tenants are, the easier it will be for users to modify their behaviour. ✔ Make smart use of the online tenant interface to provide energy advice (in bite-sized formats) to tenants.

2.6 Lesson learnt – City administration / social service providers

Category	Issue	Impact	Recommendation
Partnership & buy-in	**C-1** Support from city administrations can be essential for the success of implementation.	➔ Pilot sites where city administrations were actively and publically endorsing energy saving measures in public sector housing found it easier to obtain buy-in from all stakeholders.	✔ Explore how the implementation can contribute to the city's climate action strategy and (if applicable) local/ regional action plans for energy efficiency. ✔ Check whether it is possible and useful to combine BECA implementation with local strategies for e-inclusion and/or countering fuel poverty. ✔ Make sure that the project does not exclude tenants who do not use the internet and/or lack the ability to understand the information transmitted by BECA end devices.
	C-2 Changes in regulation of billing and relevance of ICT-services	➔ Some countries are to change current energy bills based on surface area to consumption based billing ➔ Greater involvement and concern of users with regard to energy efficiency and ICT-solution ➔ Chance for SMEs to enter the market	✔ Adopt country policies and regulation in line with the potential benefits derived from the BECA solution ✔ Take necessary measures in assuring an appropriate environment for the implementation of ICT-services ✔ Highlight benefits resulting from service usage apart from compliance
Take-up and use	**C-3** Social workers proved good in communicating the objectives of energy campaigns, and in engaging tenants to take up the service.	➔ Tenants welcomed advice coming from individuals such as social workers whom they trust to operate in their interest and who "speak their language"	✔ Discuss with social service agencies how their staff can be involved in the efforts to reduce energy consumption and fuel poverty in social housing. ✔ Provide basic training (on energy efficiency, fuel poverty, end devices) to social workers who are to support tenants in preparation of and during BECA implementation.
	C-4 Service implementation benefits from public Wi-Fi infrastructure	➔ Where all tenants had free access to the internet through a public Wi-Fi, they were making more use of the BECA energy portal. ➔ The RUAS can be used as a means to attract tenants to develop their digital literacy skills.	✔ Explore possibilities for providing social housing tenants with free internet access, e.g. through a public Wi-Fi infrastructure or a city-wide public access network.
Data privacy & security	**C-5** Some tenants expressed concerns regarding data privacy.	➔ A number of tenants declined to sign the data protection agreement, although they were initially	✔ Check possibilities for involving an independent data privacy/ security expert in the implementation

Category	Issue	Impact	Recommendation
		interested in the service. ➜ They could therefore not participate in the programme, reducing total savings.	project (e.g. consumer advocate), which would also give city administration better insight into the privacy and security implications of BECA service. ✔ Local PR activities should emphasise the efforts being taken to protect data privacy.
Technical set-up	**C-6** BECA implementation benefits from public Wi-Fi infrastructure	➜ Where all tenants had free access to the internet through a public Wi-Fi, they were making more use of the BECA energy portal. ➜ The RUAS can be used as a means to attract tenants to develop their digital literacy skills.	✔ Explore possibilities for providing tenants in public housing with free internet access, e.g. through a public Wi-Fi infrastructure. ✔ Check whether financial support can be obtained from the business sector.
Outcomes	**C-7** Where the city is directly responsible for paying the energy bills of social housing tenants, BECA offers a range of possibilities for achieving savings.	➜ Limiting the provision temperature to a set temperature (e.g. 21°C) lead to savings in energy consumption since tenants were kept from regulating temperature by opening windows. ➜ The pilot experience does *not* indicate that acceptance by tenants will be a serious problem.	✔ Press for piloting of practices which regulate energy consumption centrally, thereby leading to direct savings from lower energy bills.
	C-7 Service can be utilised to monitor temperatures across social housing stock using actual data instead of estimates	➜ This makes it easier to guarantee compliance with regulation concerning minimum temperatures to be supplied to tenants. ➜ Complaints by tenants can be addressed more effectively.	✔ Where compliance with regulation concerning minimum temperatures to be supplied to tenants is an issue, make sure that the BECA system to be implemented supports monitoring of actual room temperatures across all social housing building stock.
	C-8 Direct conversations with city council to replicate project measures in other public buildings.	➜ Help to expand the results of the project in other municipal buildings. ➜ Benefits replication of BECA solution to a wider environment	✔ Present achieved results to the municipal authorities. ✔ Plan financial funds as part of the annual budget for similar activities as the service might be attractive for being used in as part of the energy efficiency programs in the municipality.

19/05/2014

2.7 Work packages

2.7.1 Summary of results

All work packages were successfully finalised at all pilot sites. Deliverables with public status are available on the project web-site (www.beca-project.eu). Key results of all deliverables are summarised in the sections below.

2.7.2 Requirements and use case definition (WP1) & Service definition (WP2)

Approach

There have been two iterations of use cases in the course of the project to ensure that use cases are able to depict all pilot sites for which they are applicable.

A full set of use cases for the BECA service has been designed. Within each use case type pilots sites checked whether the individual use case is applicable for their planned services or not. The numeration and reference of each use case remains unaffected and allows for adding any use case at any point in time. In fact, the individual pilot sites do not necessarily have the same set of use cases depending on the focus of the proposed service.

The full BECA use case list works as an umbrella covering all individual pilot site use case lists and allows for a common and consistent documentation of the architecture.

Characteristics of use cases

Basic use case characteristics can be summarised as:

- The system is treated as a "black box", and the interactions with system, including system responses, are as perceived from outside the system.

- A complete set of use cases specifies all the different ways to use the system, and thus defines all behaviour required of the system, bounding the scope of the system.

- In BECA, each use case is described in full detail with one corresponding process model with the same name and ID.

Creation

The following provides an outline of a process for creating use cases (and process models) in BECA:

Use Case development

- Identify all the different users of the system

- Create a user profile for each category of user, including all the roles the users play that are relevant to the system.

- For each role, identify all the significant goals the users have that the system will support. A statement of the system's value proposition is useful in identifying significant goals.

- Create a use case for each goal, following the use case template. Maintain the same level of abstraction throughout the use case. Steps in higher-level use cases may be treated as goals for lower level (i.e., more detailed), sub-use cases.

- Structure the use cases. Avoid over-structuring, as this can make the use cases harder to follow.

Process Model development

- For each use case, create a first outline of the process model set based on the developed use cases. Model as much detail as possible.

- Refine the process model set based on feedback from the pilot sites (as by definition BPMN should be understandable and utilised by all business users). If needed, generalise or further specify models so that they fit all pilot site service processes.

- Create a final set of process models. Validate their technical accuracy against the BPMN specification.

Use cases and process models

- Review and validate with users.

- Iterate the entire chain of events a second time.

- Cross examine whether updates to process models affect use cases and vice-versa.

Overview of significant results

> *The full content is part of the ANNEX. This section presents one example .*

Use case and Process Model: View Consumption Data (UC4)

Exhibit 2 – Use Case Example

Name of the Use Case:	UC4: View Consumption Data
Summary	View energy consumption and other parameters
Normal flow of activities	User enters the web portal User opens the available visualisation panels in the application User looks at energy consumption in kWh/m³, € or CO_2 for different periods (15 minutes, days, weeks, months, years). User sees the link between the results by period and his energy consumption behaviour.
Alternative Flow	n.a.
Trigger	User selects the *consumption data* page on the web portal
Precondition	Metering equipment has been installed and account configured. User is logged in.
Postcondition	User can now access the visualisation components of the RUAS Tenants understand the influence of their behaviour on the consumption costs Tenants persuade others (e. g. relatives) to use the web portal

Exhibit 3 – Process Model Example
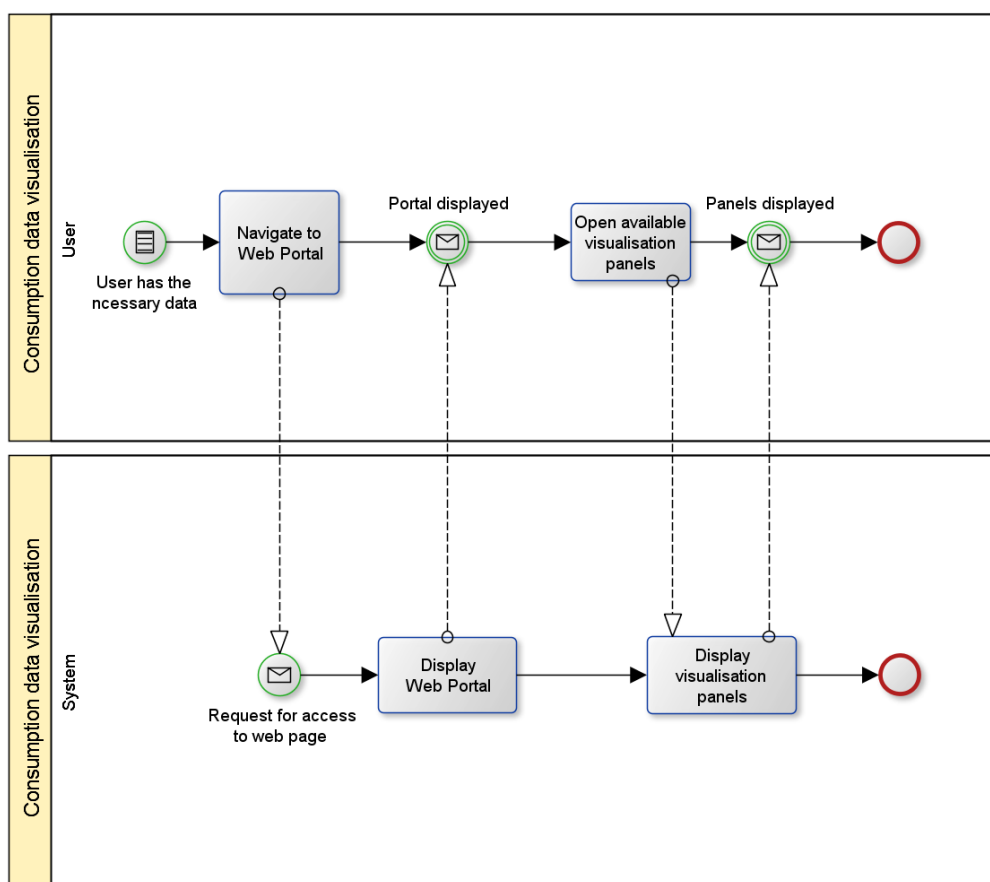
2.7.3   Service specification (WP3)

The final deliverable (D3.2) is public. This section will only present key results.

Approach and Overview of significant results

The architecture and service specifications presented below are the common BECA architecture and service specification incorporating all pilot sites. The BECA specifications are presented in UML. Thus the architecture below is able to represent all pilot sites and their features.

As can be seen below the system architectures being used by all pilot sites relate to the common BECA architecture. Site specific properties are adopted accordingly.

Whereas the "Generic Services" encapsulate services being related to security issues, error management and logging "Management" includes all those services which are necessary to configure, maintain and operate the overall system (except the meters which are handled within the Business Layer) itself.

The layers listed below are described in more in detail as part of the public D3.2.

- Data Access Layer
  - o Data Access Layer / Services
  - o Data Access Layer / Protocols
 - o Data Access Layer / FieldComponents

- o Data Access Layer / MeasurementReadings
- Business Layer
  - o Business Layer / RUAServices
  - o Business Layer / RUAServices / Interfaces
  - o Business Layer / RUAServices / Services
  - o Business Layer / RUAServices / Services / Reports
  - o Business Layer / RUAServices / Services / Alarms and Messages
  - o Business Layer / RUAServices / Services / Benchmarking
  - o Business Layer / RUAServices / Services / Self Assessment Tools
  - o Business Layer / RUAServices / Services / Data Storage
  - o Business Layer / RUAServices / Services / Data Collection
  - o Business Layer / RMServices
  - o Business Layer / Services Common
  - o Business Layer / Data Model
- Presentation Layer
  - o Presentation Layer / Devices

2.7.4   System implementation and test (WP4)

Approach

Work in work package 4 "System implementation and test" relied on tasks and deliverables that have been pursued within the BECA work packages 1 to 3 of the project's overall work programme. An iterative development approach was applied to the development of services within BECA. The relationships between BECA work packages and deliverables is depicted in the Exhibit 4 below.

Exhibit 4 – BECA work plan WP1-WP4
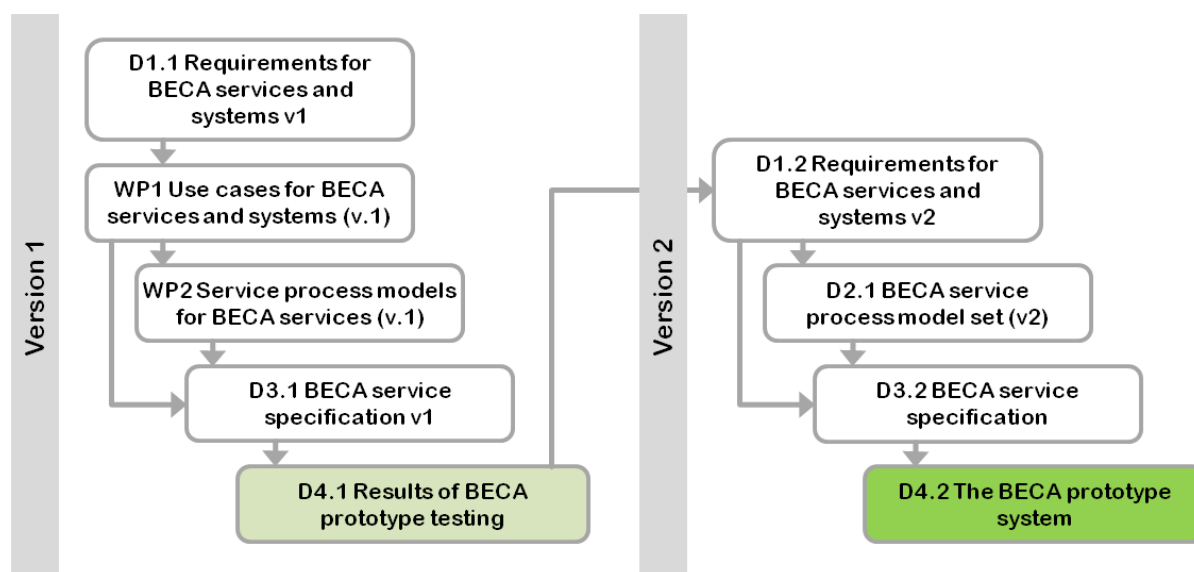
Three phases were defined focusing on different areas: While phase 1 (T4.1-4) was focused on the principle look and feel, phase 2 (T4.5-8) concentrated on usability and functionality from an end

Exhibit 5 – WP4:
Pilot Testing Timing

4

users' perspective. Phase 1 and phase 2 tests were usually executed in a lab environment. In contrast, in phase 3 tests were executed in the real and final operational environment (T4.9-10). To guarantee the overall functionality all the functional and non-functional requirements (compare WP1) were tested.

Based on the experience with tenants, the testing guide was further structured and simplified for the 2nd prototype test. It included a data gathering questionnaire for capturing relevant test results. These data have been used to check, whether the specifications and developments according to the different BECA use cases have been implemented.

The on-site test represented the final test phase in which all the functional and non-functional requirements were to be addressed in the prototype system implementations and tested by each pilot site. To do so, the generic used case diagrams and descriptions were adapted by the different pilot sites. The notation of use cases used in the very early phases of the systems engineering process describes the overall systems' behaviour in an easy to read notation. Therefore the consortium selected this notation as a basis for testing and documenting the fulfilment of the functional requirements, i.e. whether and how they have been addressed in the implemented system prototypes.

Overview of significant results

WP4 included detailed test descriptions for each site. Functional as well as the non-functional requirements were fulfilled by the different pilot sites. 7 out of 7 sites have reached a degree of fulfilment higher than 90% after the second prototype test. As a result of on-site testing, several minor issues had been identified and solved by pilot site members before operation started.

2.7.5 Pilot site preparation (WP5)

Approach

Pilot planning (T5.1): The review of pilot site plans with the final selection of RUAS and RMS for each BECA pilot site including the responsible service provider. Work related to task 5.1 was also confirming the number of buildings and dwellings the service is installed in as well as reviewing the number of prospective users of the services.

User recruitment (T5.2) and Staff training (T5.3): As indicated above, user recruitment plans and staff training had been set up earlier in the project. These plans were reviewed and implemented.

Systems introduction (T5.4) had two sub-tasks. Technical equipment installation: The outcome of this task is that all necessary equipment for operation of RUAS and RMS was installed in all dwellings. As a prerequisite equipment had to be purchased (T4.9) and tested on-site (T4.10).

The second sub-task was 'Training sessions for users': In some cases and in particular for the RUAS addressed to tenants, awareness raising coupled with training was required and carried out through different means such as, for instance, sending out brochures and organising focus groups. For more complex services (e.g. the RMS addressed to professionals) there training sessions were necessary to train staff members on how to use the service correctly. Part of this task was to identify the best means of training.

Overview of significant results

From the technical point of view, the installation of all technical equipment had been finalised at all sites. Some sites installed the majority of equipment at the beginning of the project leaving only a few components for installation before the start of operation.

To ensure a successful start of the service, some sites had included training sessions for the users in their tenant recruitment strategies. In most cases these sessions took place when the technical availability of the service for all users was ensured. Hence, training was made with 'real' data from the tenants' dwellings and that the tenants kept on using the service directly after the training.

2.7.6 Operation (WP6)

Approach

The work package 6 was the final executive phase of the project in which the services were offered to tenants in real conditions at 10 pilot sites. Pilot site managers established a local team. The team was organised to provide maintenance and user support addressing operational and technical problems that might occur during operation. A help service has been set up at each site to respond to problems faced by the tenants and the housing staff.

The organisation of the pilot operation was supported by the responsible partners and the project coordinator by providing guidance regarding organisation and through supervision of ongoing processes.

Exhibit 6 – Overview of BECA work plan approach to pilot preparation and operation
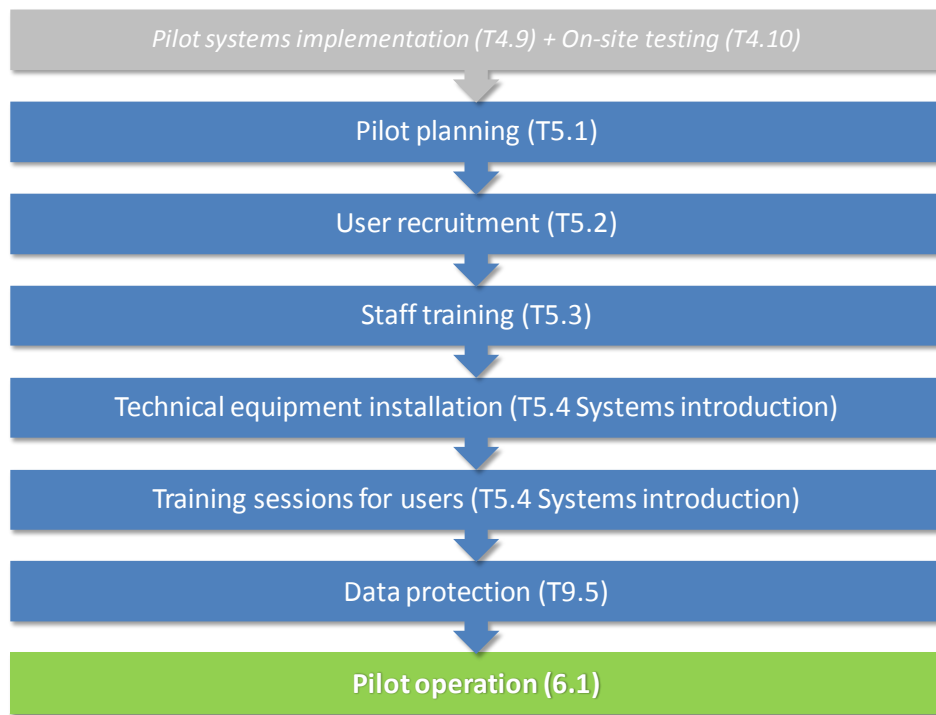
Overview of significant results

project. Deliverable D6.1 collects lessons learnt from operation as well as earlier deliverables. Lesson learnt are divided by stakeholders and describe the issue at hand, impacts observed and list recommendations. Lessons from the EC project BECA are included. The deliverable documents pilot operation, processes and structures implemented to ensure delivery and full maintenance of RUAS and RMS.

Innovation triggered: Many lessons have been learnt during operation in seven pilot sites across Europe. Conditions, particularly in the Eastern European Market, are different across sites and the integration of lessons is a major contribution to this deliverable as much as the 'Guide for Replication' benefiting future implementations of ICT-enabled energy efficiency services.

2.7.7   Evaluation (WP7)

Approach

BECA follows the common methodology of all energy efficiency projects funded under the CIP programme. One result is the common tool for calculating energy savings called eeMeasure. The web-site (www.eemeasure.smartspaces.eu) documents the current version of the methodology as well as the tool.

This approach is oriented at the IPMVP (International Performance Measurement and Verification Protocol)[3]. In IPMVP, four options (A-D) are given for measurement and verification, but in the context of BECA only option C is applicable. Option C describes a pre-post-comparison (before and after an intervention) using prior consumption for an estimation of "non-intervention consumption" (e.g. no implementation of an ICT-based consumption feedback solution such as BECA RUAS/RMS). An additional (or alternative) calculation model is a control building (control group) approach, appropriate when no baseline energy consumption data is available.

Pre-post-comparisons

In order to calculate changes in energy consumption in consequence of an intervention (e.g. RUAS or RMS) a comparison of measured energy consumption data before (baseline period) and after the intervention start (reporting period) is useful. Ensuring the comparability of baseline and consumption data is important. In the best of cases both, baseline and reporting period, cover full operating cycles (e.g. one heating period or one year).

Exhibit 7 – Before-after-analysis of one building
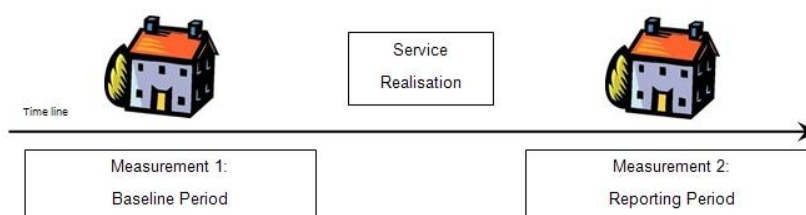
Depending on energy type the measured consumption data have been analysed related to the dwelling size (m^2) and / or the number of persons in the dwellings.

Furthermore, temperature adjustments have been carried out when comparing the heat energy consumption within different heating periods in order to account for climatic effects. The standard

---

3   see IPMVP public library of documents:

http://www.evo-world.org/index.php?option=com_content&task=view&id=272&Itemid=60&lang=en
(Retrieved 20 March 2013)

practice used by EU member states, a heating degree day calculation model (HDD), has been used (taking methodological differences[4] into account). Degree-day-correction allows comparisons of consumption data related to several time-periods (e.g. years, heating periods) – regardless of the diversity of climatic conditions of these measurement periods, of the location of the settlement / building, etc. By using correction models it is possible to calculate relative differences in consumption figures for one and the same building in several heating periods as well as comparing various buildings or projects in the same or several years, etc.

Comparison with control building/control group

If no appropriate baseline energy consumption data is available (e.g. new constructions or extensive refurbishment), a control building design allows for collecting comparable energy consumption data. A control building is a similar building matching the characteristics of the experimental building (e.g. kind of building, location, equipment, insulation, heating system, relation of public and private areas) as best as possible, but is, for instance, not equipped with an energy management system.

Exhibit 8 – Control building design
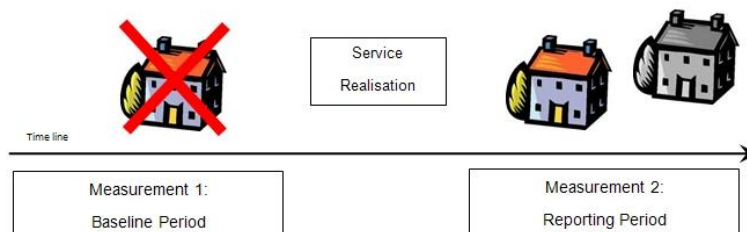
The same logic applies to a control group of tenants. While one group of tenants, for instance, has access to consumption feedback via web portal (experimental group); the tenants in the control group – living in the same or a very similar building – cannot access the portal.

As the name implies, the advantage lies in the opportunity to control for intervention impact and for other influencing effects. At the best, the only difference between both, experimental and control building / group, is the availability resp. absence of an intervention.

Overview of significant results

Overall results revealed a great success that can be enlarged by extending the operation period of the services, giving the tenants more time to adapt their behaviour. For the resources covered by the majority of sites savings of 15% for heat energy, 11% for cold water and 17% for hot water have been achieved. Only for electricity the target was not met (2%). However, it has to be taken into account that the most effective way to achieve meaningful electricity savings is to replace old electric appliances by new and less energy consuming ones. The tenants of social housing often do not have the means for doing so and assess it as not useful to replace appliances when the old ones still work well. As all pilot sites will continue the provision of their services they can base their future campaigns, energy coaching and further activities on the current success of the project.

The combined analyses of consumption data and survey data has shown various relations between ecological awareness as well as ecological behaviour and the achievement of savings. Higher savings where achieved at most pilot sites when the energy saving norm increased together with interest in saving energy at home and in possibilities of saving energy at home. The data allowed for analysing the relation between the retrospective view of the tenants and the achieved savings at one pilot site: Tenants who stated to know more about their energy

---

[4] Different are – for example – the heating limit temperatures: Germany 15°C (low energy houses 12°C, passive houses 10°C); Belgium 16.5 °C; France 18 °C.

consumption due to the tenant portal or stated that they now keep an eye on their energy consumption performed better than tenants who do not think so. Furthermore there is evidence that improved behaviour and achieving savings are related to the frequency of portal logins. At most pilot sites medium and or heavy portal users performed better than weak users.

Pilot Sites

There are differences across pilot sites illustrating the importance of individual contexts, conditions and dispositions in the national societies for the achievement of savings. With respect to heat energy consumption the pilot sites at Darmstadt and Örebro achieved the highest savings of 20% and 19% which is mainly due to using RMS which automatically optimises the supply water temperature in the case of Darmstadt and sets the indoor temperature at a maximum of 21 degrees Celsius at Örebro. Related to cold water consumption Belgrade and Örebro achieved the highest savings of 16% and 37%. These high savings in Örebro are at least partly due to a specific condition introducing a new billing system with now water expenditure calculation on the basis of the actual consumption of the tenant households. This made tenants very responsive to the RUAS services. At Belgrade the experimental group tenants showed a remarkable increase in their subjective energy saving norm, therefore felt responsible to save energy and improved their behaviour related to water consumption. The highest reduction of hot water achieved again Örebro due to the above mentioned reasons (35%) and Torino (31%) where the mainly elderly tenants with low pensions have been highly motivated to save money. Regarding electricity consumption that was part of the project at three pilot sites, Ruse achieved the highest savings with 6% by targeting high-consumers with additional coaching.

2.7.8 Dissemination and Exploitation (WP8)

Approach

Dissemination

Dissemination work and activities include regular communication activities undertaken by each consortium partner such as conference, workshop attendance and organisation of own events, meetings, website updating, newsletters, press articles for general or professional publications for social housing organisations and ICT suppliers.

Exploitation

Work on viability assessment and exploitation planning included development of the cost-benefit analysis tool (CBA). Partner sites have entered data into the tool and calculations have been run for each pilot site. Results have been discussed and further refined with partners to identify most appropriate business models for the BECA services in different constellations and by different stakeholders. The analysis included a qualitative assessment of goals and barriers as well as on-going exploitation activities.

Exhibit 9 – Cost-benefit Analysis Tool overview
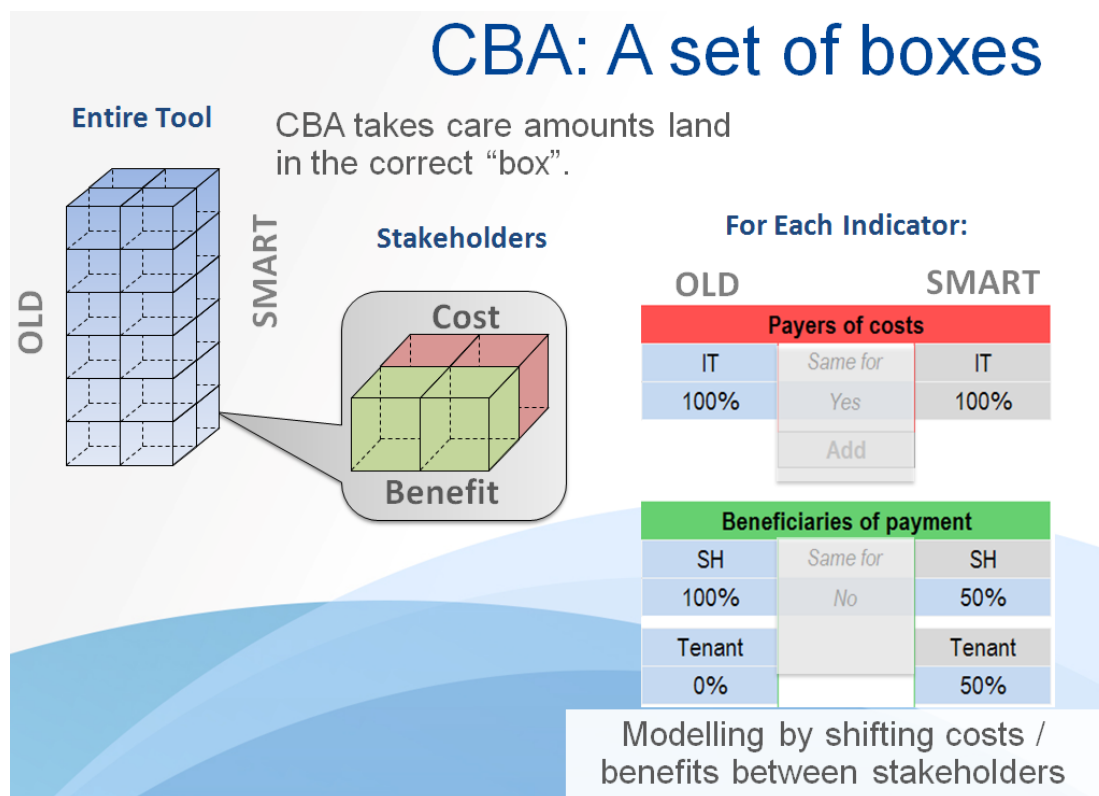
> *Interpreting the socio-economic return ratio:*
>
> *Any percentage above zero implies that the investment pays off and that for each Euro invested all investing stakeholders combined receive the according sum in Euro back. For instance, a value of 120% means that for each Euro invested the stakeholders get 1,20EUR as profit (+1 EUR for costs) back.*

The following (simplified) formula describes how the result is depending on all indicators entered (i), the stakeholders (j) and the result for each year (k), which is cumulative over all years prior:

$$\frac{\sum_i^n \sum_j^s \sum_k^t b_{ijk} - \sum_i^n \sum_j^s \sum_k^t c_{ijk}}{\sum_i^n \sum_j^s \sum_k^t c_{ijk}} = Return_t$$

A more detailed explanations and formulae including depreciation can be found in deliverable D8.3. It has to be noted that overall results vary over time given that costs and benefits are not necessarily the same and can be subject of change each year. Consequently, the total socio-economic return may take different paths over years and a more detailed overview of the typical paths it can take is provided in the following sections. The graphs depicted below can be compared with the result for each individual hereby, helping to interpret the outcome.

Overview of significant results

Dissemination

> *The dissemination activities of the project and project partners are described in detail in D8.4.*

Dissemination

In the final year alone, the consortium has released 46 dissemination publications and participated and / or organised 49 events.
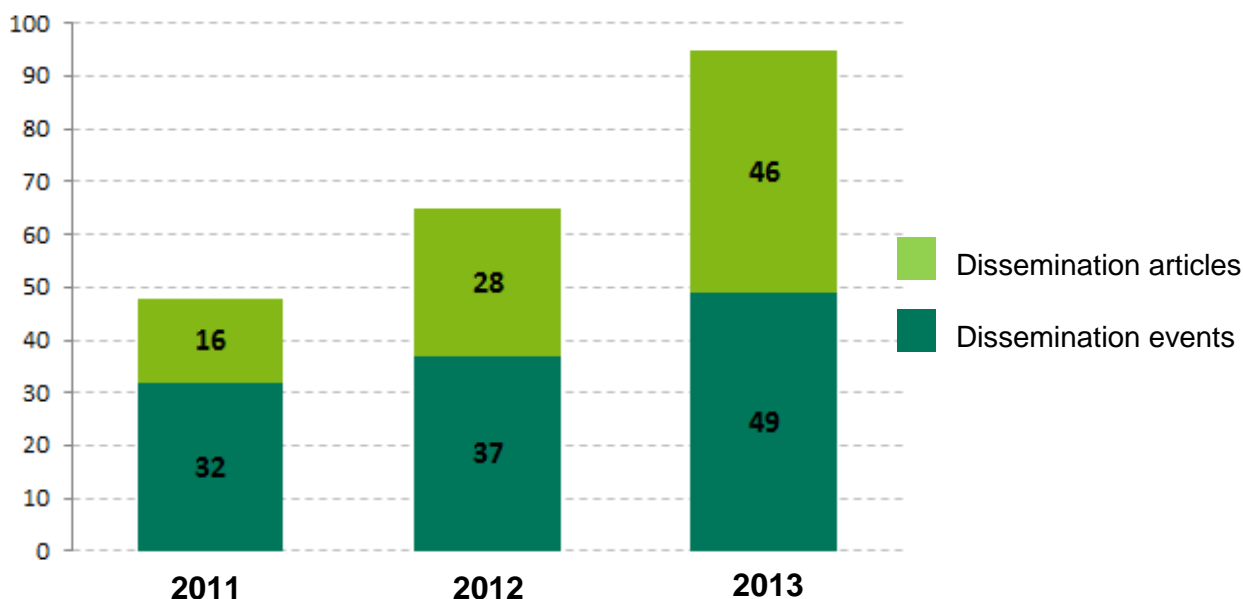
Dissemination activities in each year

Each year, the consortium has organised more dissemination events and published more articles than the previous one, leading to a total of **115 events** organised and **89 articles** published during the three years of the project. Considering the total amount of dissemination activities for the three years, the consortium has organised, on average, **almost 6 dissemination activities (articles or events) for each month of the project.**

	2011	2012	2013	TOTAL
Newsletters	2	3	3	**8**
News items	0	27	23	**51**
Articles	16	28	46	**90**
Events	32	37	49	**118**
TOTAL	**48**	**65**	**95**	**208**

Accordingly to the dissemination strategy, dissemination activities have reached a grand diversity of target groups, to ensure maximum dissemination of the project results and ensure its optimal exploitation, both during the project and after its end.
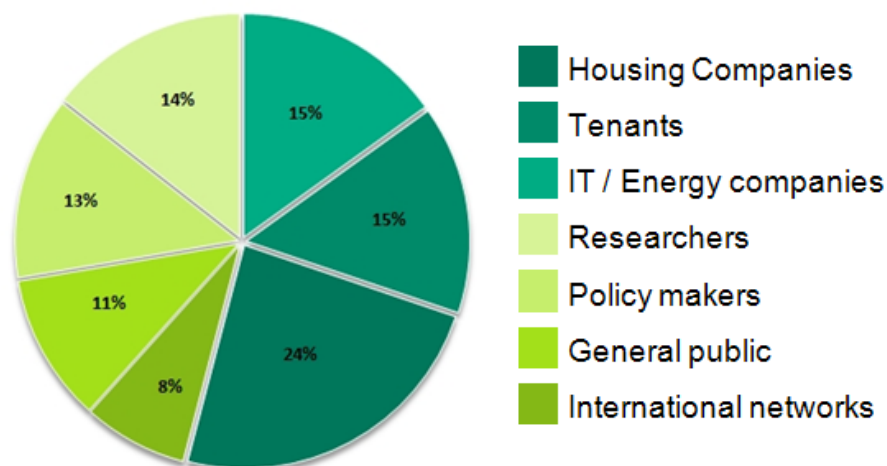
Housing companies have been the main target group for dissemination events, with almost ¼ of the dissemination events including them as target group. The consortium has also managed to maintain a balance between all identified target groups : tenants, IT companies, Researchers and policy makers.

Exploitation

BECA introduces the methodology covering qualitative and quantitative means of analysis. The qualitative analysis is following the SWOT approach. Each site identified internal strengths and weaknesses of as well as exogenous opportunities for and threats to the service. The input has been iterated multiple times and validated with the result of quantitative means using a cost-benefit analysis (CBA) realised as an Excel-tool. CBA follows EC guidance on metering deployment [2012/148/EU]. The tool collects a wide range of indicators in the areas implementation (CAPEX), operation (OPEX) and consumption. The CBA tool compares the 'do nothing' scenario with the intervention measures implemented in BECA.

Innovation triggered: A common methodology has been developed to assess the exploitation potential for ICT-enabled energy efficiency services. The view across seven pilots ensured the most relevant indicators were identified. Moreover, analysis has shown that the fastest return on investments are achieved with heating and water.

A 'Guide to Interpretation' helps to quickly and easily understand key terminology and results generated as part of the analysis.

The project identified recommendations, barriers and scenarios which help Exploiting the BECA Solution. Recommendations target market (players) and policy actors as well as interest groups. It is recommended to implement ICT-enabled services as energy management services (RMS) first a focusing upon heating and water. There is a great market potential in countries in which billing is not based on consumption while it is possible that prices for metering equipment might decline. Policy actors have to remain active in the field of data privacy and standardisation. Further research is required to fully exploit the data generated with smart metering and to proof that business models can be based upon it.

Barriers for BECA like services remain with the restrictions upon exploiting the full potential of smart-metering based services. This becomes even more relevant when existing (local) actors create restriction regarding access to hardware or data hereby increasing cost and risk for service providers. Barriers on the demand site include a lack of trust in smart-metering. Generalised exploitation scenarios are outlined for exploitation driven by public institutions, newcomers and market players. Stakeholders considering a scenario should validate their own situation with the lessons learnt provided in the 'Guide for Replication'.

Pilot Exploitation analysis has proven that working services are viable under the given conditions. Total return on invest - all stakeholders in the pilot site together - is reached across all sites within

a few years. This does not imply that an individual stakeholder might require a few more years to get their investments back. Degree of functionality correlates with technical requirements and costs. This correlation is particularly strong for implementation costs but also holds for operation costs since financing the investments is often based on future payments. Sites, in which consumption based billing is not the standard ('Do-Nothing' scenario) require more years to break even. A main reason being infrastructure not present and additional effects need to be accounted for (e.g. more communication).

The SWOT highlights the importance of local conditions for implementation of ICT-enabled services. For many tenants, the concept of paying their own consumption is new as much as being able to influence the amount to be paid. The differences across sites are not limited to internal strengths and weaknesses but also face varying opportunities and threats often resulting from regulation and current market players.

BECA Cost-Benefit Analysis tool: Display of ROI
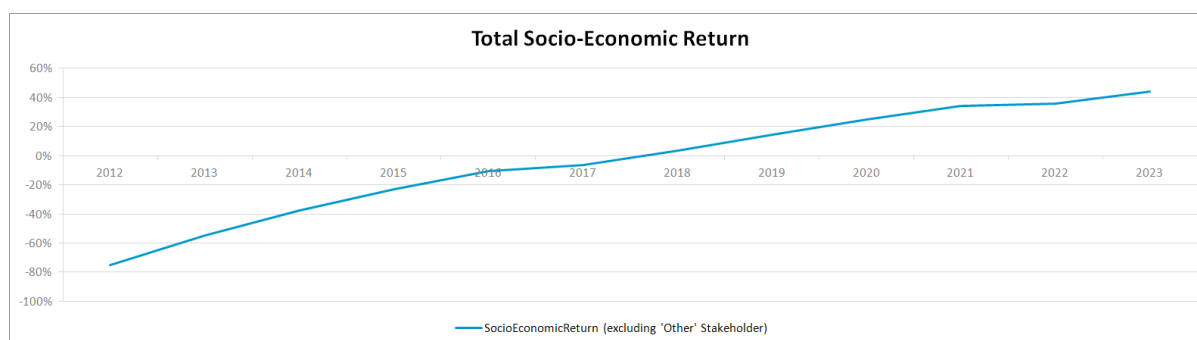
Guide for replication:

> *The complete Guide is part of the document and can be found in the ANNEX.*

The 'Guide for Replication' has three parts. First, smart-metering and ICT-enabled energy saving services are introduced so stakeholders with no experience can be approached. Second, the Guide provides stakeholders with steps to be taken at various stages of project deployment. For each step, relevance for stakeholders is pointed out and lessons learnt provided for individual stakeholders. Finally, key information for project set-up and checklists introduced earlier are collected in the Annex.
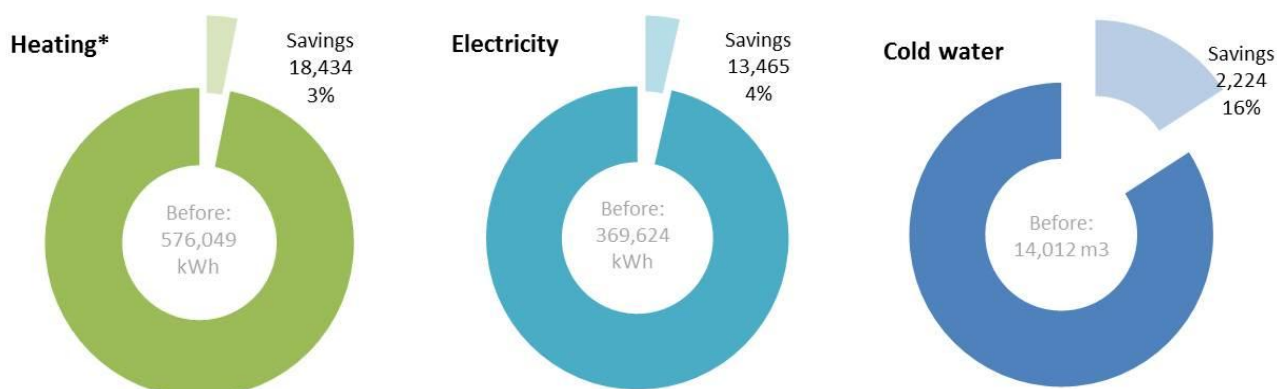
2.8 Pilot sites

2.8.1 Summary of pilot results

All pilot sites successfully implemented the services while learning valuable lessons in the process as well as from each other. All tenants of all sites have the possibility to access the BECA service and the continuity of BECA services is guaranteed. In fact, most sites have already deployed the solution to other sites or are planning to do so in the next years.

2.8.2 Belgrade (Serbia)

University of Belgrade (MEB)		JKP Beogradskeelektrane (BEOELEK)		BELIT
Buildings	3	Dwellings	184	
Age	1960	Services	RUAS, RMS	
Resources covered	Electricity, Heating,	RUAS Media	web-portal, mail, letter, hotline, education,	

| cold Water | alerts |

Heating* Savings 18,434 3% Before: 576,049 kWh

Electricity Savings 13,465 4% Before: 369,624 kWh

Cold water Savings 2,224 16% Before: 14,012 m3

* Related to Tower A only (n=46) with both RMS and RUAS; for more details see the specific heating chapter below

Pilot Overview

The pilot site Belgrade (Serbia) includes three buildings in the municipality of Palilula, City of Belgrade. The three high rise buildings have a total of 184 dwellings with a combined surface of about 9,300 m². Built in the 1960's, the buildings are typical representatives of that period of Serbian housing with poor thermal insulation and high energy consumption.

The dwellings in Tower A equipped with the BECA services range in size from 48 m² to 57 m². The average level of education of tenants is medium; a lower number has a university degree or high school education. Tenants' internet access rate is rather low (30%). Most of them perceive "economic savings" as the main benefit of the BECA project. Together with the project partners University of Belgrade – Faculty of Mechanical Engineering (MEB), JKP Beogradske elektrane (BEOELEK) and Belit. The services offered in the pilot site are based on monitoring data for electricity, water, and energy consumption.

Service summary

RUAS – service description

Tenants were provided with access to an internet portal that gathers information on their water, energy (for heating) and electricity consumptions. Heating energy consumption measurements took place through heat cost allocators. It has been agreed on data provision to the server and data exchange protocols (web service / XML, TCP/IP, FTP). An agreement was reached with the water and electricity provider for making these measurements available using their own metering equipment and for a data exchange with the server.

RMS – service description

The fuelling of the boiler facilities were changed from coal to solid biomass and the control of boiler operation was improved. Tenants were able to control room temperatures. Information about tenants' consumption was made available, as well as a "cost calculator". The service was implemented as a web-based information system.

Quantitative Analysis (CBA)

The path for total socio-economic return is almost steadily increasing and crosses the point of return after around 6-7 years. The baseline scenario (Do-Nothing) is rather optimistic given the likely change of legislation to implement billing based on consumption. This change would require additional metering (for some resources). As a result, the entire path would be moved upwards as implementation cost for smart metering would be partly compensated for. Measuring of dwellings (rather than buildings) is likely to induce fees for *Tenants* which would increase the slope of the path. On the other hand, dwelling based billing may (or may not) induce some resource savings which would reduce the slope of the path. Overall, the CBA analysis presented can be considered

as a "worst case scenario". This is particularly true for the business model of the *IT*-provider relying on further exploitation and - considering the current environment without regular exchange of metering equipment – likely economies of scale.

Total Socio-Economic Return

SocioEconomicReturn (excluding 'Other' Stakeholder)
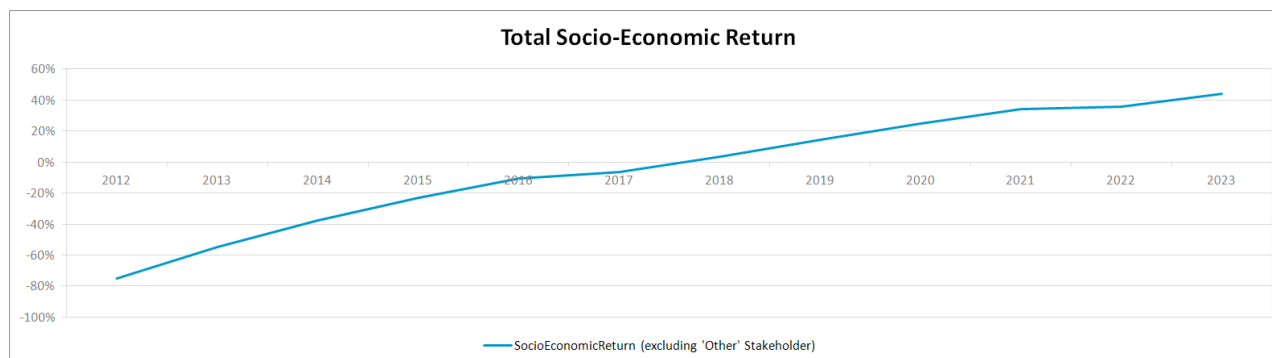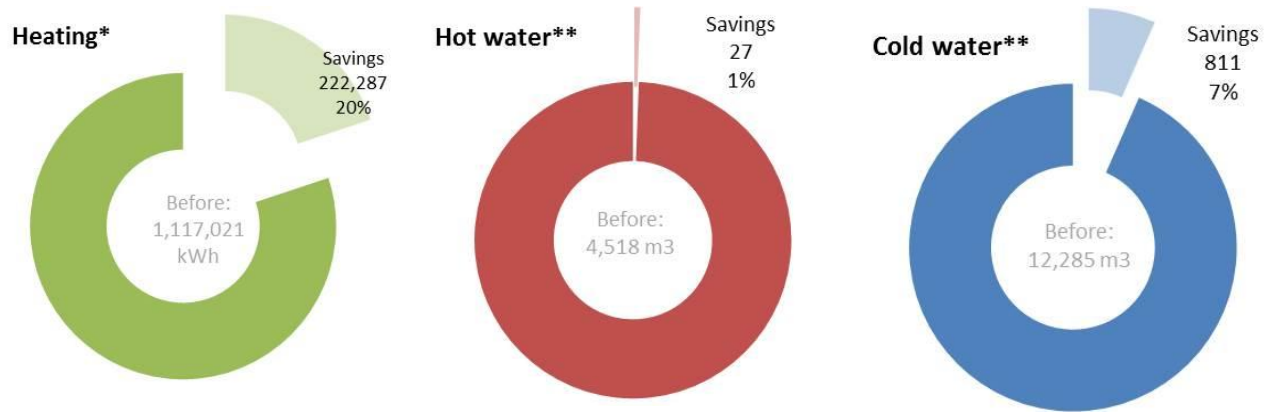
Value Propositions

Service users are attracted by the opportunity tenants have to constantly monitor and analyse their own consumption data (electricity, cold water, heat, etc.), as well as to draw comparisons with respect to other similar households in the building. The variety of functionalities embedded in the BECA solution is highly appreciated by tenants. Prior to the introduction of the BECA service, tenants were receiving only bills with cumulative consumption figures and without any detailed explanation or potential advices for adjusting consumption behaviour in order to achieve energy savings. With this regards, BECA solution helped tenants to become more aware of their amount of energy consumed as well as assisted them in changing their behaviour towards resource consumption optimization. In order to help tenants properly use the provided BECA solution, various coaching sessions for tenants were organized. A hotline service set up to assist tenants' queries with regard to service use resulted effective, especially for the elderly people. In addition, on-site computers, on-site internet connection, as well as various education materials about energy efficiency issues resulted effective in raising tenants' awareness and changing their behaviour toward resource consumption optimization.

Future Exploitation

Currently, consumption is not paid per amount of units consumed, but per surface area. Hence, monetary savings are shared among all tenants of a given building which resembles a large burden for rolling out the BECA solution (for more detail see SWOT section below). However, the legislation is currently being revised and the "pay what you consume" is very likely to be introduced in the near future. Consequently, this will open the market for (smart) metering of dwelling specific consumption which can – at the same time - be combined with ICT based services such as BECA. There are 300,000 dwellings in Belgrade alone and it is hoped that at least 10% of the market can be reached within two years with further potential in the future in Belgrade and across Serbia.

2.8.3   Darmstadt (Germany)

	bauverein AG (Bauverein)		Techem Energy Services GmbH (TECHEM)
Buildings	45	Dwellings	675
Age	1959-1986	Services	RUAS, RMS
Resources covered	Heating, hot and cold Water	RUAS Media	web-portal, education, alerts

Heating* Savings 222,287 20% — Before: 1,117,021 kWh

Hot water** Savings 27 1% — Before: 4,518 m3

Cold water** Savings 811 7% — Before: 12,285 m3

* related to top and medium setup with RMS and partly RUAS available (n=210) related to a three-month observation period (Dec – Feb); see explanation in the background chapter above

** related to top setup with RUAS available (n=188 resp. 189)

Pilot Overview

The pilot site of Darmstadt (Germany) includes 45 buildings in Darmstadt and in the nearby smaller towns of Dieburg, Weiterstadt and Bensheim. The buildings have a total area of approx. 55,000 m² with 675 dwellings accommodating approximately 1,514 tenants.

The buildings were built between 1959 and 1986; the facilities for energy, heating and water were installed between 1974 and 2003. Thus, the quality of the meters, the need for heating and the energy efficiency differ among the buildings from medium to low. All dwellings were equipped with smart heat cost allocators and modern thermostatic valves.

A high proportion of tenants in the pilot site dwellings receive social welfare benefits and have a migration background. They are varying in age (18 to 85) and have a medium/low educational background.


The pilot site is divided in 3 categories with different levels of service:

- Basic setup: 15 buildings (266 dwellings) are equipped with radio frequency heat cost allocators, water sub-metering services and remote reading infrastructure.

- Medium setup: 21 buildings (189 dwellings) have the basic setup plus a service which consists of a device that optimizes the heating curve of the central heating system according to the real demand of tenants.

- Top setup: 9 buildings (220 dwellings) have access to the medium setup plus an access to an internet portal.

The bauverein AG Darmstadt supported by Techem implements and pilots Resource Usage Awareness Services (RUAS) to encourage tenants to save resources (energy, hot and cold water) and Resource Management Services (RMS) for resource usage reduction.

Service summary
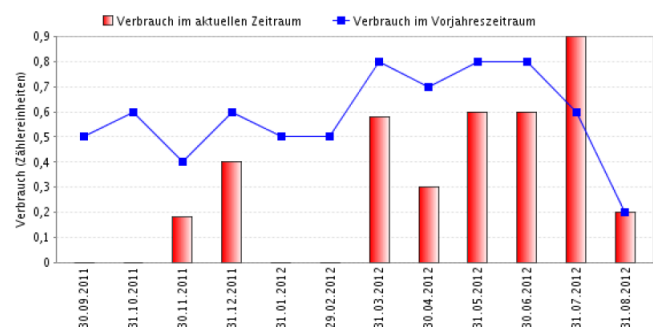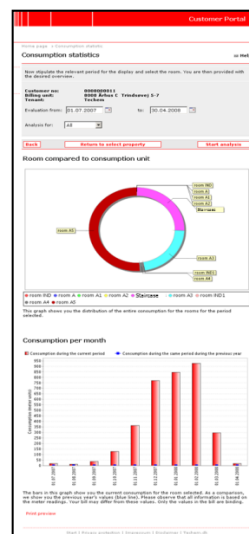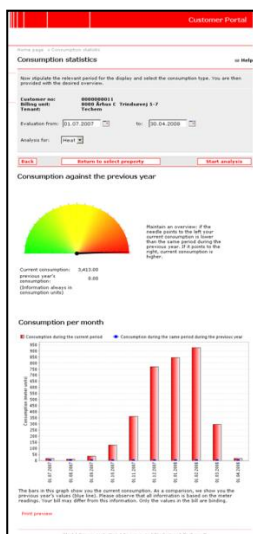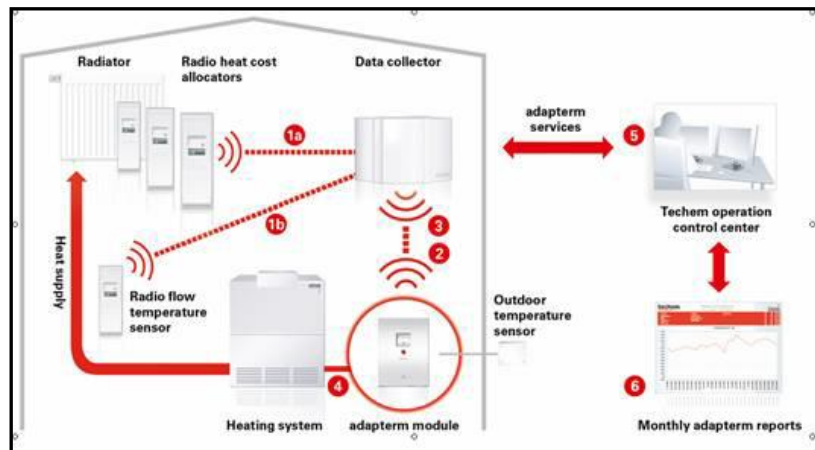
RUAS – service description

The RUAS depends on the level of service of the building concerned:

The **basic setup**:

- Installation of radio frequency heat cost allocators and radio frequency hot and cold water meters.

- Automated reading of all metering devices via a fixed wireless network.

- Access to the Techem web portal by Bauverein and all other pilot site specialists involved to frequently check the consumption figures per dwelling or per building.

The **medium setup:**

- Basic setup as described above + installation of the RMS "adapterm" to save further heating energy due the frequent optimization of the heating curve of the local central heating facility.

The **top setup:**

- Medium setup as described above + all tenants have access to the Techem.Portal solution to check and compare their heat and water consumption values whenever they want, enabling tenants to directly take actions for further savings.

RMS – service description

Implemented on buildings concerned by medium and top setup, Techem's adapterm energy saving system reduces heat consumption by optimising the heating curve of the central heating system according to the real energy demand of tenants. The energy savings due to adapterm are frequently presented in the adapterm cockpit via internet.

Quantitative Analysis (CBA)

The path for socio-economic return is steadily increasing and pays off immediately. The baseline scenario (Do-Nothing) is assuming an automated market without capacities for RUAS and RMS. Since the market for water and heating measurement services in Germany is shifting towards automated reading, the *Measurement / IT*-provider is not only competing with the price but also with the services derived from the new infrastructure and data available. Hence, being able to provide RMS and RUAS services is essential for the business case. No direct costs were recorded for the *Measurement*/*IT*-company since the product was sold to the housing company and it is assumed that any costs are included in costs charged.


Value Propositions

BECA provides high saving potentials, especially for larger developments. The energy management service (RMS) can be deployed to heating systems being able to almost immediately achieve savings. The automatic adjustment of the technology resolves the issue of disincentives for maintenance workers: Without BECA high effort is required to optimise a heating system while any tenant complaint – justified or not – about low heating temperatures would create additional work for the maintenance employee. Over time, the rational choice was to let the heating system run on a high setting. The data collected with BECA and the RMS operating upon it, provides the necessary proof to quickly and easily resolve complaints that the comfort of tenants was not reduced. This is being ensured by the back-end of the application capable of integrating large number of buildings and providing the administrative and technical workers with all information available (while complying with the strict data protection code). The energy awareness service (RUAS) can be considered an additional feature providing tenants with further capacities to reduce consumption as much as an archive for historical data and maybe even bills in the future. Interested users could have a wider range of tools to analyse consumption.

Future Exploitation

The measurement sector in Germany is changing and - as BECA is proving in Darmstadt - smart-metering is not only becoming as standard for electricity but also water and heating. Assuming the usual replacement rate of metering devices and cooperation of social housing companies (and potentially other building owners) around 15,000 buildings (200,000 dwellings) are likely to be equipped with smart-metering devices the coming 3-5 years. In this scenario, almost half a million service users could have access to a web-portal. Given Techem is an international player, the hardware used as well as the additional services such as the tenant portal could be implemented also in other countries. bauverein will include the solution in future refurbishment activities and is considering to further integrate the RUAS platform with an overall service for tenants.

2.8.4   Havirov (Czech Republic)

MESTSKA REALITNI AGENTURA SRO (MRA)		STU-K AS (STUK)	
Buildings	2	Dwellings	72
Age	1962	Services	RUAS
Resources covered	Heating, hot and cold Water	RUAS Media	web-portal, mail, letter, hotline, education, alerts
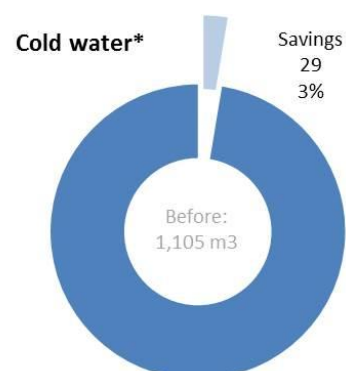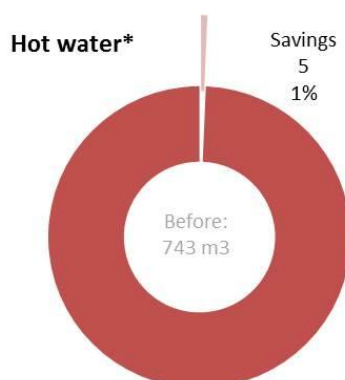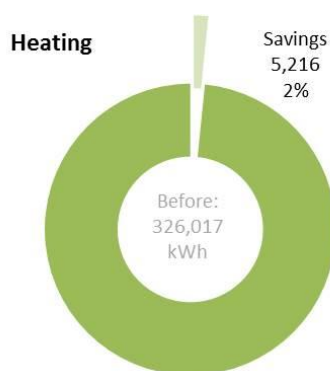
* Related to hot and cold water a sub-group of the experimental group could make use of RUAS

Pilot Overview

The BECA pilot site in the Czech Republic is located in Havirov, a city with 78,713 inhabitants (number 1.1. 2013) founded in 1955, in the north-eastern part of the country. The first pilot building for the BECA project is situated in J.Jabůrkové Street in the city district of Mesto. It was selected as a typical multi-residential building from the municipal housing stock. This 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.

The second pilot building is located in Uzavřená Street at a distance of 180 m from the first building and is nearly identical. The second building has the same parameters as the first building (the same typology, number of apartments and has also undergone refurbishment).

The buildings were selected as they are located in an attractive downtown area with long-term occupants, most of whom use the internet on a daily basis. The first building has a total surface of about 1,761 m² and the second building of 1,780 m².

Tenants in the pilot site are mostly Czechs with medium/low education background. The Havirov team in BECA project has implemented innovative Resource Use Awareness Services (RUAS) for tenants.

Service summary
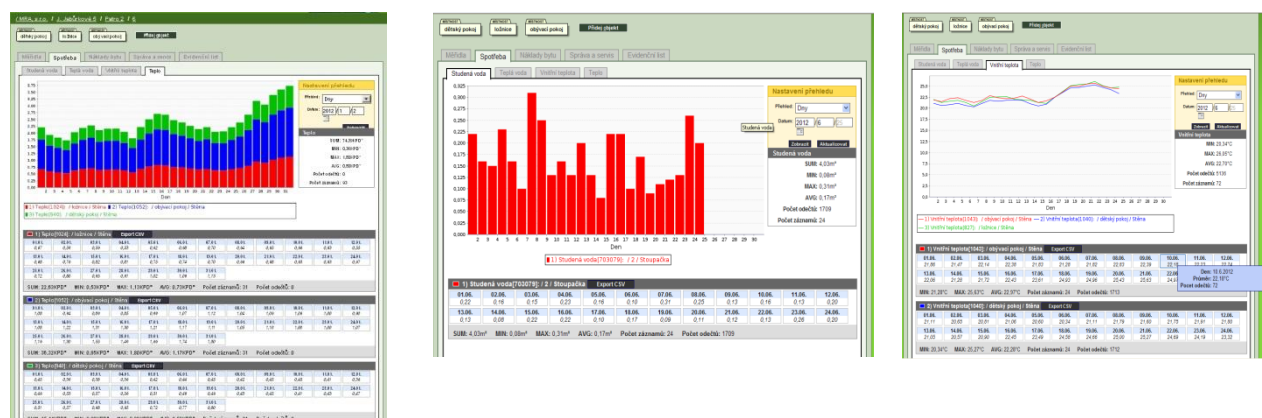
RUAS – service description

Tenants have received access to the web application where they can follow their current consumption of water and heating energy in graphical and numerical form. They can select various time periods of visualisation of consumption data. The heating consumption is indirectly measured with units measuring temperatures and the total consumption in the house distributed across dwellings according to temperature. Tenants continued to pay on the basis of m² of their flat but RUAS should work as a motivation to save energy.

Quantitative Analysis (CBA)

The path for total socio-economic return is almost steadily increasing and crosses the point of return after around five years. The baseline scenario (Do-Nothing) is rather optimistic given only implementation cost for (cheap) heat cost allocators have been considered and no operation cost included (which would resemble a steeper path for BECA). As the business model(s) of competitors in the newly developing measurement market is not fully known, the cost-benefit analysis has been performed cautiously. The stakeholder graphs show: *Tenants* only have to expect losses during the implementation phase while the first replacement (assuming *Tenants* to be the payers once more) will have already paid for itself. The benefit path for *Social Housing* follows the cost curve and total socio-economic return is heavily influenced by changes in, either, cost or benefits. Since the total revenue stream for *Social Housing* is low, however, risk (and opportunity) are not endangering the companies' business model in either case.

Total Socio-Economic Return

SocioEconomicReturn (excluding 'Other' Stakeholder)
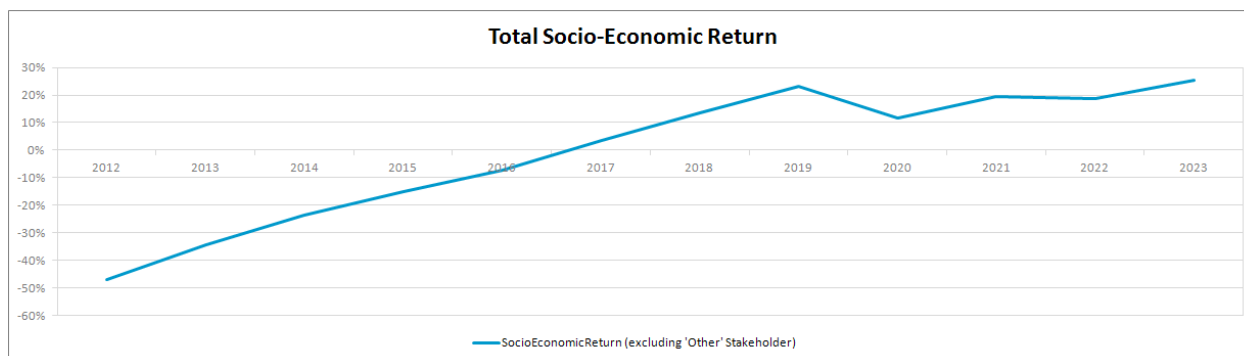
Value Propositions

The BECA solution provides tenants with the possibility to continuously follow their water and heating energy consumption, so that they are able to influence it over time. The users can also compare their consumption behaviour with previous periods in time. Before using BECA, tenants received only paper bills once a year (in April). Competitors use heat cost allocators that measure heat consumed on radiators, while the degree day method used in the BECA solution also reflects heat transfers among individual apartments. BECA makes tenants aware of their energy consumption while providing feedback and automatically generated tips for saving. The solution allows the social housing provider to monitor and detect malfunctions of metering equipments as well as any "tampering issues". Also, through the BECA service, the housing provider can check in real time for any potential anomalies in the energy use of apartments.

Future Exploitation

The solution already has been installed in several houses (condominiums, housing co-operatives) in Prague. The system can be implemented in any multifamily house. MRA has already collected information in apartments which have access to the internet. Refurbishment measures will be combined with the service in order to assist tenants in achieving the saving potential. In the coming three years this should be the case for 20 buildings (720 dwellings) resembling 1,500 additional users.

For the whole of Czech Republic, the law providing obligation of metering heating consumption per flat has been approved. Further regulation allowing metering with degree-day method is anticipated which will make the cost-efficient BECA system a prime candidate for the entire housing stock.

2.8.5   Manresa (Spain)

	International Center for Numerical Methods in Engineering (CIMNE)		Foment de la Rehabilitació Urbana de Manresa (FORUM)		Pich-Aguilera Architects (PICH)
Buildings	3			Dwellings	122
Age	2007, 2011			Services	RUAS, RMS
Resources covered	Electricity, Heating (gas, solar), Water			RUAS Media	web-portal, mail, letter, hotline, education, coach, alerts

Heating

Savings
7,276
6%

Before:
125,460
kWh

Cold water*

Savings
40
5%

Before:
848 m3

Electricity*

Increase
+1,386
+5%

Before:
28,279
kWh
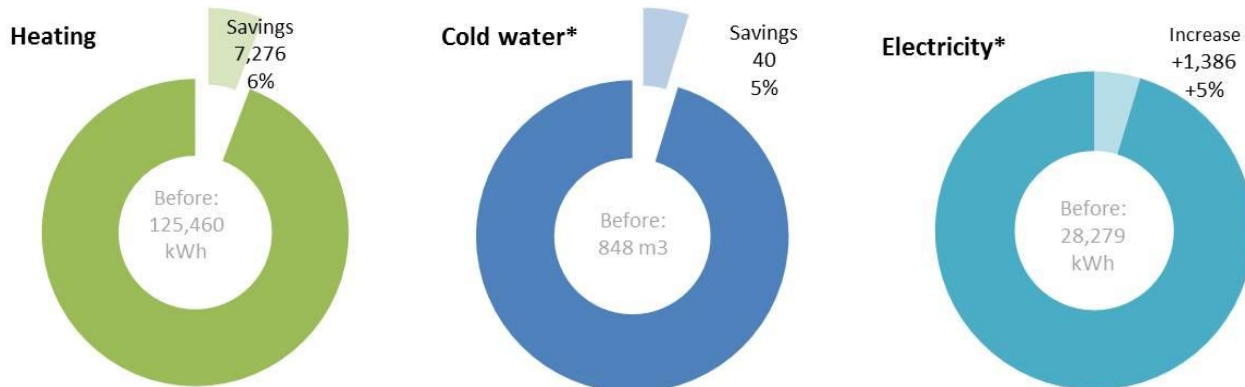
* Shortened comparison periods of eight month in each case (see explanation above)

Pilot Overview

The pilot site Manresa consists of three buildings in the capital of the Bages comarca. The three blocks have a total surface of about 20.000 m² building area with 130 dwellings (12, 52, and 66 per building), commercial areas and parking. The total area of 130 dwellings participating in the project, varies between 32m^2 to 75m^2. The first building was finished in 2010; the second was finished in October 2011, while the third one was finished in the middle of 2007. All blocks were built according to modern energy efficiency standards (including good insulation, natural ventilation, and glazed galleries). Each building has a centralized heating installation with a centralized solar thermal system and low temperature condensing boilers back up support systems. This centralized installation provides Space Heating (SH) and Domestic Hot Water (DHW) to each dwelling. Metering and control equipment have been installed within distribution closets placed at the block stairs and inside the apartments. Individual thermostats providing indoor temperatures and instantaneous energy consumption are installed in the building where services are offered to tenants.
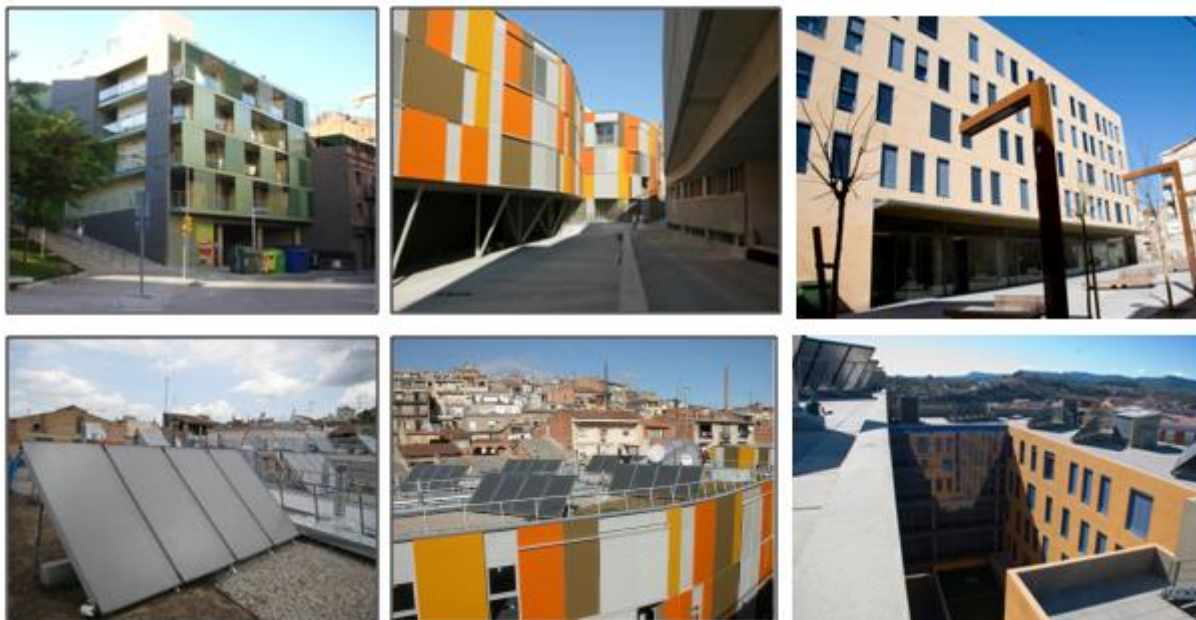
Tenants at the pilot site are young to middle-aged Spanish with a high representation of migrants. The number of persons living in the dwellings varies from 1 to 8 tenants. Literacy levels and share of social benefit receivers is sensibly high, also due to the actual economic situation in Spain. Plus, internet access is quite low as well. Tenants addressed during services operation period have said about the services that they think it could help them understand how they waste energy and money using supplies.

Service summary

There are three levels of energy monitoring defined in the pilot site: basic level for establishing the base line consumption and the control group for the evaluation of the energy savings, and first and second levels of monitoring for providing RUAS and RMS to tenants and to the housing company.

The basic level of monitoring has been established across the total number of 130 dwellings and consists of gathering of space heating and DHW data, and electric consumption, in a monthly basis. Eight of these dwellings are for sale and their occupation, and the consent for using their energy consumption data depends on the future owners. That's why those dwellings have been excluded from the services list. Data gathered has been used for establishing the base line consumption prior to the start of the services, and some of the dwellings have been used as a control group also during the service operation in the rest of the dwellings
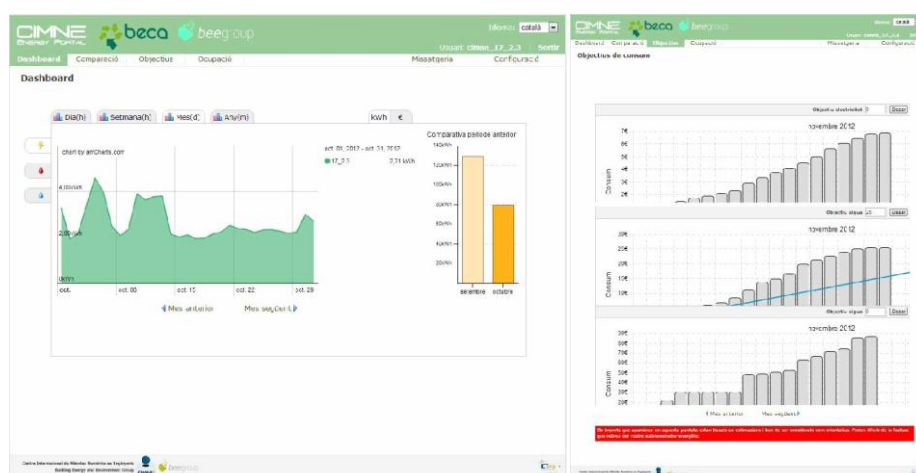
The RUAS and RMS services have been provided to 44 rented dwellings in the Montserrat 1-23 building. The first level of monitoring is applied to 38 of these dwellings and consists of data gathering in 15 min intervals for overall electric consumption, space heating, DHW and cold water.

The second level of monitoring applies to 6 dwellings, and in addition to the first level, it provides sub-metering of 3 electric lines and the measurement of the indoor temperature and relative humidity. One Nexus 7 tablet has been provided to each dwelling at this level, as additional interface for tenants to facilitate the use of the services.
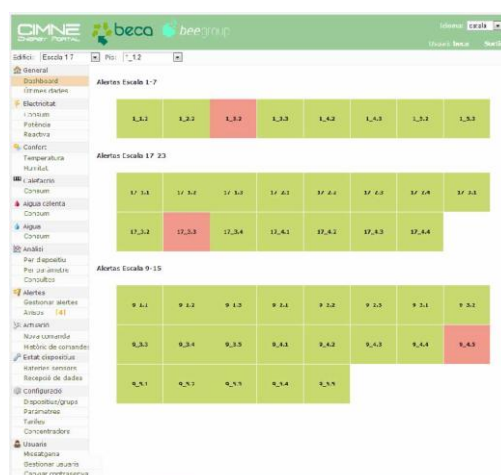
In addition to the individual measurements per dwelling, the solar fraction from the central solar system of the central heating system is measured at building level. The data is offered as part of RMS services to the housing company technical staff.

RUAS – service description

The service collects information on water, electricity, solar production, space heating and DHW consumption. The portal provides tenants with access to historic consumption on different time scales. Personalised saving tips are generated automatically according to the consumption. Tips not only depend on consumption resulting in generic advice (e.g. lower temperature of thermostats) but take into account the environmental influences and suggest appropriate actions (e.g. consider closing thermostats while opening windows).

RMS – service description

The RMS monitors the energy produced by solar system and aims to assure the achievement of the projected solar fraction, early fault detection and maintenance management. In many cases the solar thermal systems, which are obligatory for new residential buildings in Manresa, do not operate properly and this has not been detected for a long time. This has led in lot of cases to higher consumption and higher energy bills for tenants. This situation could be improved substantially with early detection and corrective maintenance.

The services will be automatic and do not require specific actions from tenants or the housing company. Automatic maintenance warnings are created from the monitoring system and sent to maintenance staff. Monitoring of the solar thermal contribution is installed in the central solar system. The solar contribution to water heating is calculated by the monitoring system back office. When there is thermal energy consumption for three consecutive days, but there is no solar energy contribution, the system sends automatically an alert to the maintenance staff.

Quantitative Analysis (CBA)

The path for socio-economic return is almost steadily increasing and starts positively. The baseline scenario (Do-Nothing) is on a high level as the existing solution is already reasonably smart and the difference of implementation cost, therefore, low. Nevertheless, the cost of equipment is the reason for the delayed pay-off for *Tenants*. Any reduction in hardware (and installation) cost would move the cost path downwards. The benefits of the *Social Housing* provider are designed to pay for the cost of operation. The benefit, in absolute terms, is small (a few thousand Euros) and could probably be increased with further optimisations. No development costs were recorded for the *IT-company* since the product was sold to the housing company and it is assumed that any costs are included in the fee charged.
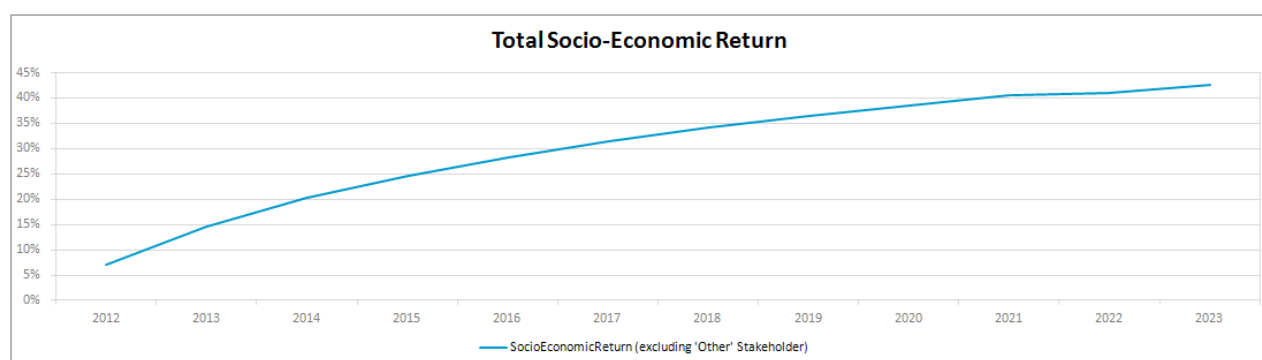
Value Propositions

BECA solution provides tenants with an informative on-line service offering complete overview and insight into their consumption on a timely basis. The service includes different components extracting information from the gathered data: Comparison with previous periods; and other tenants; self-assessment tool and a mailbox to receive personalised energy saving advices and alarms. A monthly energy report on paper is delivered to each tenant, summarising the most relevant energy information and energy saving tips which are based on automatic analysis of consumption behaviour. The tenant feeds the system with further information by "occupation profile" avoiding false alarms (and providing data for the RMS). The system is capable of

facilitating the tenant's understanding by sending automated alarms which propose at least one (concrete) action which can help avoiding the unnecessary energy consumption. BECA incorporates control over the local heat production (solar system) and water management. It allows optimising the solar system operation and helps to detect leaks or abnormal gas performance. Technical staff receives energy consumption overviews for the whole building and tenants almost in real time. Set alarms notify technical staff about any failure or abnormal consumption, enabling them to take action.

Future Exploitation

All beneficiaries in the project are planning to exploit the solution. CIMNE has established a spinoff company called Inergy (link) continuing to develop the BECA solution and actively engaging social housing companies across Spain to consider the IT-solution as part of refurbishment efforts as well as a stand-alone measure to increase energy efficiency. In the near future it might possible to exploit the market in other Spanish speaking countries. Forum considers the technology as a key feature in future housing developments. Further experience is required to also include refurbishment scenarios. PICH has already implemented BECA in other social housing developments being one of the main architects covering another 90 dwellings. These figures are expected to grow once the economical crisis ends and the building sector revived.

2.8.6   Örebro (Sweden)

ÖrebroBostäder AB (Orebro)			
Buildings	22	Dwellings	432
Age	1965 (refurbished 2010); 2011	Services	RUAS, RMS
Resources covered	Heating, hot and cold Water	RUAS Media	web-portal, mail, education, coach, alerts

Heating — Savings 937,804 19% — Before: 4,988,804 kWh

Hot water* — Savings 758 35% — Before: 2,146 m3

Cold water* — Savings 1,392 37% — Before: 3,802 m3
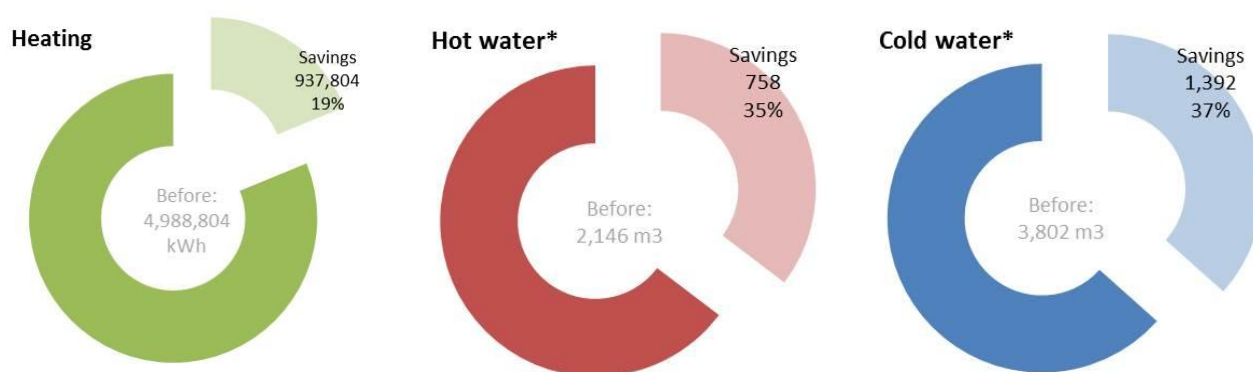
* (n=67)

Pilot Overview

In Örebro (Sweden) several buildings in different areas of the city are pilot sites of the BECA project:

- Varberga – 180 dwellings
- Pålsbodagatan 13 & 15 – 24 dwellings
- Drottninggatan 33-37 – 48 dwellings
- Örnsköldsgatan 147-151 – 45 dwellings

- Björkallén 26-68 and Rosta strand 35-57 – 33 dwellings
- Restalundsvägen – 101 dwellings.

The BECA pilot site service includes a Resource Usage Awareness Service (RUAS) to tenants on cold and hot water as well as a Resource Management Service (RMS) of indoor temperature to optimize the heating system. Within the project, the existing systems of the houses are improved by raising the awareness for consumption through access to and visualization of consumption information. Tenants have access to their consumption data both through their invoices and via a web service. All measurement data are collected in a database, allowing a third party supplier to add new services such as visualization of consumption data via mobile phone.
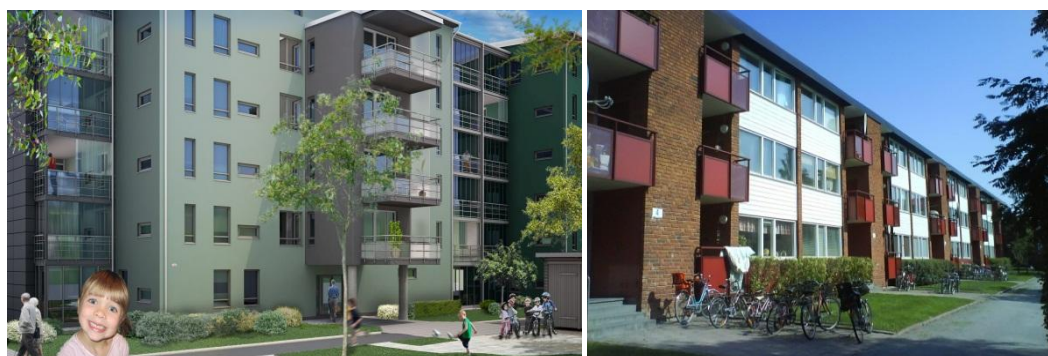
ÖrebroBostäder is the only company involved in the Swedish site; no partners are included in the project.

Service summary
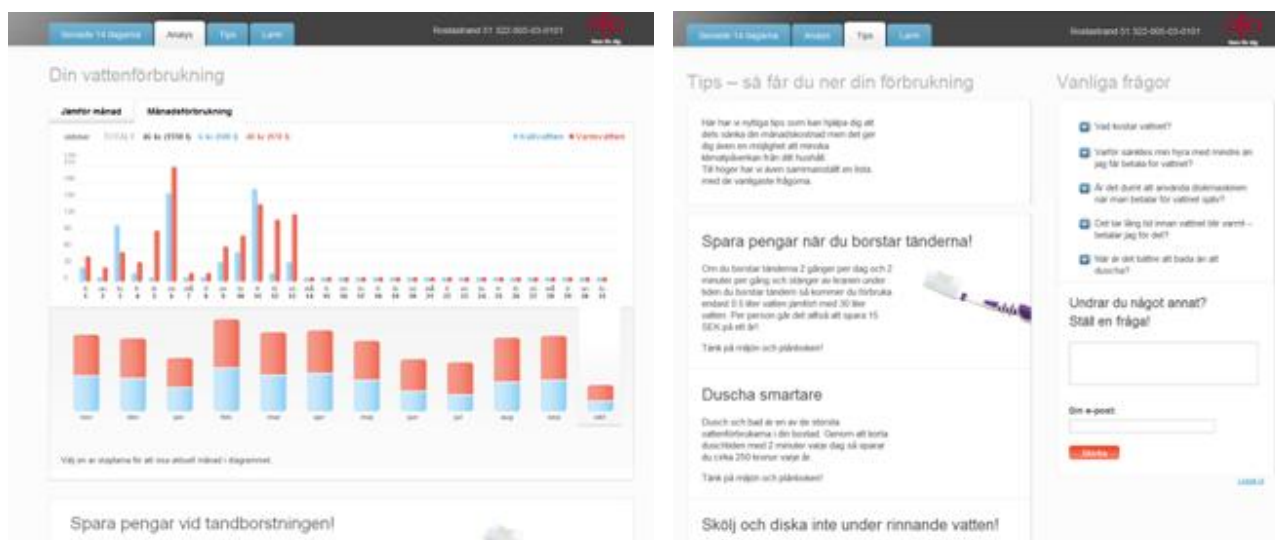
RUAS – service description

Before the BECA project, expenses for both hot and cold water consumption were included in the rent, it didn't matter for people how much water they consumed. With RUAS all tenants have to pay for the water consumption in the dwelling. When the system started, all dwellings got a reduction of the rent level. The level of the reduction is based on an agreement with the Tenants Association. A large dwelling has a higher reduction than a small one. The total rent reduction for all dwellings is not the same amount of money as the cost for the water, before BECA. According to the agreement the reduction is based on the cost of a normal consumption of water, not the average. From the day when tenants got the reduction they also have to pay for their own consumption of both hot and cold water.

Every month tenants get their invoice where they are able to see their water consumption and the cost. If they want more information or if they would like to check the consumption in detail, they are able to use a web portal. At the web portal they can follow their consumption of water and find more information about how to save water and also get in contact with the housing company's technician. The service makes it easier to save water and understand how much water they use every day.

During the midterm survey some users gave us tips and ideas of how to develop the web portal. Those changes have been made and hopefully all our tenants appreciate the changes.

RMS – service description

Heating costs are included in the rent. It is adjusted in the long-term according to changes in consumption and price of resources. The maximum inside temperature in all dwellings is set to a maximum level of 21 degrees Celsius in order to avoid tenants overheating their flats. The frequency of temperature measurements is set to 15 minutes. It is expected that this kind of service will allow for savings of 4 to 6 %. Before BECA and the RMS service a lot dwellings were over heated because we didn´t know the indoor temperature. It can differ a lot from one dwelling to another and before BECA we had do make sure that the coldest dwelling got 21 degrees Celsius. With BECA we control all dwellings and make sure that they have 21 degrees Celsius, no overheating of dwellings.

Quantitative Analysis (CBA)

The path for socio-economic return is steeply increasing in the first years before flattening in the long run. As explained in the summary, the path for *Tenants* is dominated by suddenly paying for the consumption of water – different to the other pilot sites. Several monetary benefits for Tenants cannot be recorded such as avoided rent increases caused by continuously increasing consumption as well as reduction of consumption beyond reaching the "normal level". The baseline scenario (Do-Nothing) is rather optimistic as no cost for (legally required) metering was included

since the business model and equipment to be chosen by competitors is unknown. This is (in part) being compensated for by not recording the development costs (as the platform is also being used in other contexts and separating the costs was impossible). Since cost for metering is likely to be higher (also considering likely fees) the result for *Social Housing* is precautious.

Total Socio-Economic Return

SocioEconomicReturn (excluding 'Other' Stakeholder)
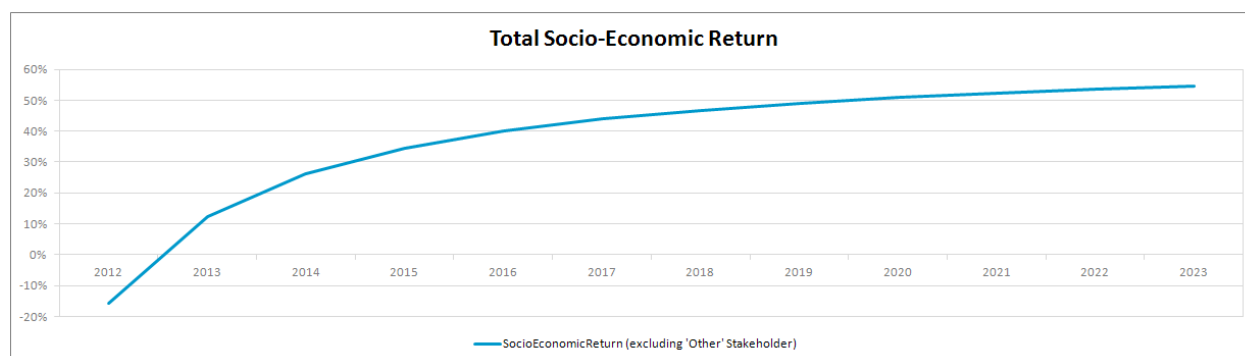
Value Propositions

The platform of the BECA solution is highly modular and flexible. Along with various communication channels the platform is also prepared to cover other resources and means (as it has been proven by the laundry extension). ÖrebroBostäder AB owns (and develops) the system ensuring long-term control and flexibility helpful in the housing sector. The solution is considered to be very stable and based on proven standard components. Using wires, batteries in the meters do not need to be changed and the equipment is long-lasting (est. 15 years). The web portal is considered to be user friendly, easy to navigate and requires little learning effort. Before BECA, tenants' water consumption was included in the rent, hence, there was little immediate monetary incentive for the individual to reduce water consumption as the fixed fee was negotiated with Tenant Association based on the total consumption. BECA is one several trials in Sweden to implement metering and consumption based billing. The RMS also ensures that heating consumption can be reduced for each dwelling without reducing the comfort. By controlling the overall temperature within dwellings (and the building) the total heating energy "tapped" from the district heating grid can be reduced. Ultimately, wastage can be avoided and the management can theoretically enable the district heating provider to supply more buildings without additional production.

Future Exploitation

ÖrebroBostäders management group and board have adopted the BECA-system, and it is now a standard in all new dwellings and refurbishments. In 2013, approximately 200 additional dwellings were equipped with the BECA. In 2014 over 300 additional dwellings are to be equipped. The ambition is to equip between 1,500 and 2,000 dwellings per year. ÖrebroBostäders is in touch with large housing companies in Sweden interested in the services implemented. Learning from the BECA experience we hope they will install the BECA service or parts of it. Additionally, elements of BECA are used to charge tenants for usage of laundry rooms which was included in the rent. One consequence is very high energy consumption for laundry. The system was tested and evaluated in almost 700 dwellings: Energy consumption decreased by 30% also reducing the cost for maintenance; most of the tenants appreciate the system while 10-15 percent do not. After discussion with the Tenants' Association, the system will be introduced in two other areas in Örebro with a total of 2,200 dwellings in February 2014.

2.8.7   Ruse (Bulgaria)

	Association Municipal Energy Agency Ruse (AMEA)		Municipality of Ruse (RuseMun)		University of Ruse Angel Kanchev (UNIRUSE)
Buildings	2			Dwellings	120

Age	refurbished 1999	Services	RUAS, RMS
Resources covered	Electricity (also heat), cold Water	RUAS Media	web-portal, mail, education, alerts

Electricity

Savings 7,908 6%

Before: 134,032 kWh

Cold water

Savings 206 8%

Before: 2,546 m3
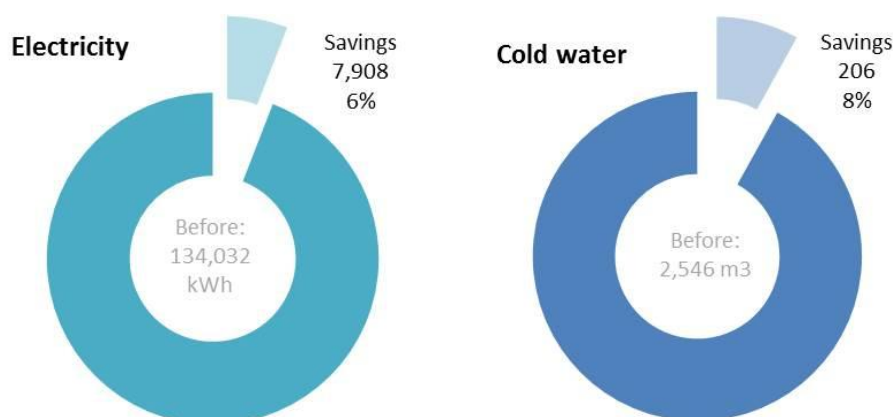
Pilot Overview

The pilot site is located in the city of Ruse, the fifth largest city in Bulgaria. It includes two buildings, with 120 dwellings and a total surface of 8,269 m². The buildings have been built in 1999 and 2001 and are owned by the municipality`s company 'Zhilfond'. 48 dwellings with different surface areas varying from 46 m² to 100 m² have been equipped with BECA solution. BECA service was offered to 126 tenants of different age groups and with different educational level (medium and high), most of them Bulgarians and generally with internet access at home. By logging into the web portal tenants are able to get real-time information on their amount of electricity and water consumed. In addition, tenants receive automatic personalized tips to optimise their consumption behaviour for saving energy resources. When necessary, face-to-face meetings were organized with tenants who encountered difficulties in using the web portal or ICT technologies. At the experimental site, main metering devices for electricity and water were installed in the communal spaces, as well as electricity meters for the elevators and the communal space lighting.

Service summary

RUAS – service description

Tenants have access to the following services:

- Web portal for consumers, providing energy and water consumption information for each dwelling.

- Monthly electronic reports with recommendations on the resource consumption.

- Graphical comparison of the energy consumption with previous periods and similar households.

RMS – service description

The RMS is focusing mainly on energy coaching and personal energy and water saving advices for heavy consumers. It includes:

- Monitoring electricity and cold water by internal and external experts in order to provide advises on the optimization of the systems and uses.

- Based on periodic information about the consumed energy and water of the targeted group dwellings, AMEA and experts from the University of Ruse implemented statistical analyses. AMEA experts that did the energy coaching have proposed energy and water saving measures to optimize the resource consumption, including the decrease of peak energy consumption. The best practices from other BECA partners and other projects were introduced to the tenants.

Quantitative Analysis (CBA)

The path for socio-economic return is almost steadily increasing and crosses the point of return after around two years. The baseline scenario (Do-Nothing) includes all relevant costs and benefits. Since the *Tenant* has almost no costs compared to the current situation, he fully benefits from the savings achieved with BECA. The *Measurement* provider, on the other hand, cannot catch up with the initial cost of implementation. However, the graph clearly shows that the point of break-even is coming closer over time. Shifting the path upwards by demanding a higher initial fee from the Tenant or a yearly fee for the service – hereby increasing the slope of the curve – could easily lead to a positive result. Given the much higher total amounts the *Tenant* is saving, it would not endanger his positive outcome.

Total Socio-Economic Return

SocioEconomicReturn (excluding 'Other' Stakeholder)

Value Propositions

BECA helps tenants to stay informed about their daily consumption of water and electricity and to change their behaviour. The BECA service provides savings tips based on their consumption behaviour and allows tenants to validate changes by customising the intervals at which data is displayed. Furthermore, tenants appreciate the feature of being informed of daily cost of consumption since the price varies throughout the day and effort is required for calculation. In Bulgaria, energy efficiency efforts are a new development and the specialised internet portal set up for tenants (www.beca-ruse.eu) provided helpful information and useful advices on energy saving measures for all consumers. In this context, BECA provides a broad database which can be used by researchers, developers and technical designer to facilitate energy saving measures in future efforts. The housing provider considers BECA as an important tool and savings achieved contribute to the targets set by the municipality. In comparison, similar services from suppliers only inform their staff members and data is only read on monthly bases to minimise costs.

Future Exploitation

In the coming two years, the BECA is likely to be implemented in the student dormitories being part of the University of Ruse. The dormitories consist of 6 buildings and 610 dwellings. They are inhabited by over 1,800 students every year. Further replication can be achieved at a national level if the hostels project is successful.

The software developed for the BECA services is being offered to utility companies and local energy providers which will have to gradually update the current metering equipment and install remote metering devices. In this context will be used in the extended Ruse Area in related project for achieving energy efficiency. This also includes the cross-border development programme Romania – Bulgaria in which all the BECA pilot site partners have previous experience.

2.8.8 Torino (Italy)

	Agenzia Territoriale per la Casa della Provincia di Torino (ATC)		Department of Electrical Engineering at the Politecnico di Torino - POLITO
Buildings	18	Dwellings	697
Age	1980; 2003-2006	Services	RUAS, RMS
Resources covered	Electricity, Heating, cold Water	RUAS Media	web-portal, mail, letter, hotline, education, alerts

The calculation of the global heat savings following a pre-post comparison led to the results shown in the both following figures. Due to the very different characteristics of the three pilot sites related to heating, the global heat energy savings had to be calculated separately for each sub-site: The experimental group of MOI with the possibility of RUAS use achieved the highest savings of 7%. In Orbassano, where a RUAS as well as a RMS is in operation, 6% savings could be achieved. In

Spina 3, where tenants could make use of a RUAS providing combined feedback of heating and hot water generation, the consumption stayed more or less unchanged (small savings of 0.4%).
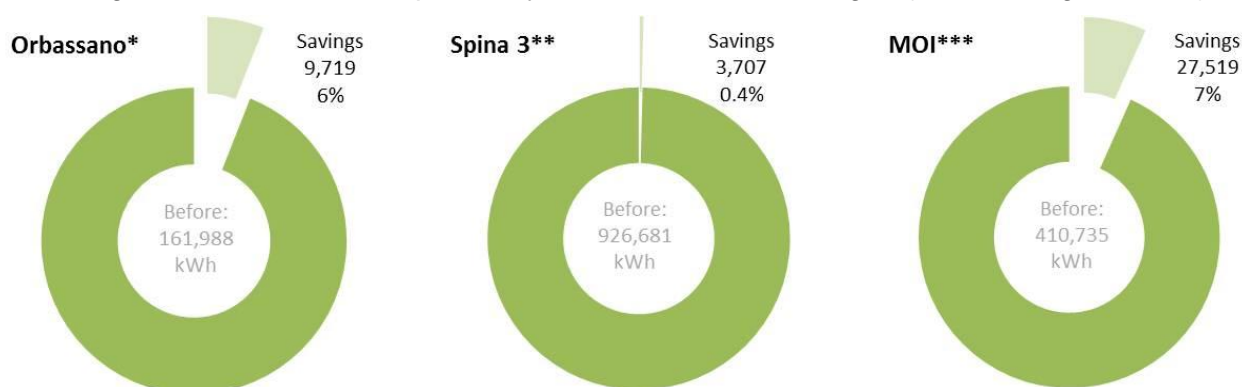
* Experimental group with both RMS und RUAS (n=39)
** Experimental group with RUAS only, hot water generation included (n=149)
*** Experimental group with RUAS only (n=55)

Related to domestic hot water, the Orbassano tenants achieved enormous savings of 31%. In the case of cold water, which is part of the RUAS in Spina 3 and MOI, the achieved savings of 1% are even smaller.
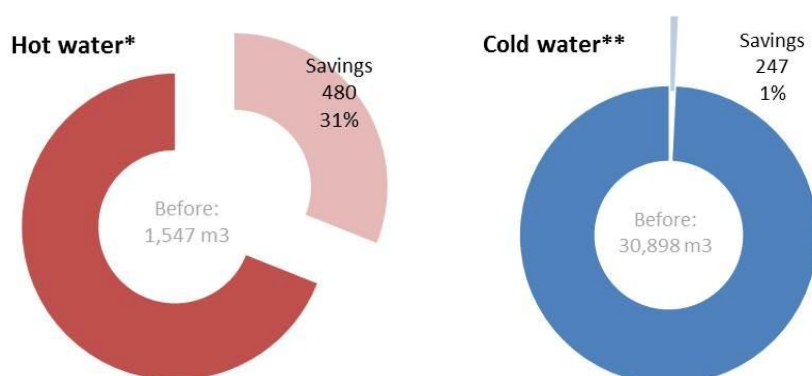
* Related to Orbassano experimental group only (n=39) with both RMS and RUAS
** Without Orbassano, where cold water was not part of the RUAS (included: n=219)

Pilot Overview

The pilot site Torino (Italy) includes two urban neighbourhoods, MOI in the south of the metropolitan Turin area and Spina 3 in the north side and part of a suburb of Orbassano in via Riesi and via Calvino. The three buildings with 697 dwellings have a total surface of about 44,606.60 m² (size from 30 m² to 90 m²). In MOI and Spina3 the buildings were built between 2003 and 2006: In Orbassano they were already built in the late 1980s; however they have been under renovation between 2005 and 2009. The buildings vary in energy performance from high (MOI and Spina3) to medium (Orbassano)..

Different elevation of MOI buildings showing the external finishes and windows

Courtyard of MOI showing distance between buildings

Courtyard of MOI showing the absence of architectural barriers

Aerial view of Spina 3

Three measurement and control systems from service providers Johnson, Caleffi and Techem, are used in the pilot. Initially all service providers agreed on allowing ATC to use the data collected by their systems in an unified and common portal without further interaction necessary during the process of data download. During project implementation some issue arose principally regarding Caleffi. At present, Caleffi gives in fact permission to ATC to acquire the data but does not provide for on-line transmission of data. To acquire automatically the data from Caleffi requires an onerous transaction that cannot be sustained with the project funding. Further to negotiations with Johnson and Techem, at present all data are being sent to ATC server and migrated to ATC portal. To fully enable the functionality of tenant facing web-services and the Resource Management Services (RMS), system upgrades were implemented.

Service summary
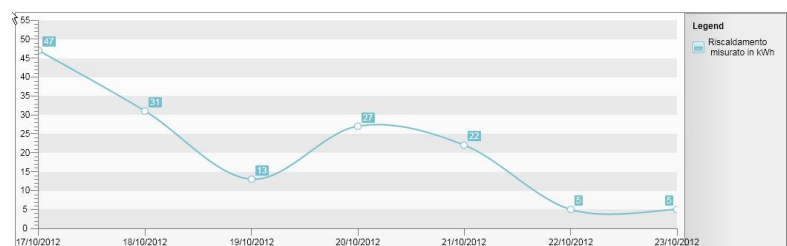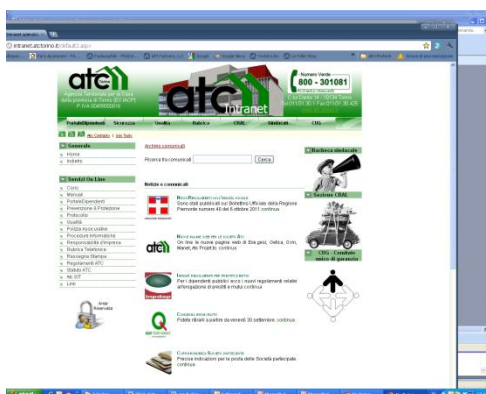
Consumption graphic table

RUAS – service description

All tenants (in all three sites) have been able to access the new web portal to check their consumption (heating and hot water). The access was granted by inserting PW and Username (must be given the username and password, ATC is caring presently to create the required number of PW and Usernames). The real IT knowledge in ATC social housing has been evaluated in order to estimate a real perspective of portal use in the pilot site.

From past experience on web based services from ATC to tenants, it has been detected that the use of internet is quite common in general. ATC offers a range of services on line through his web page such as:

- newsletter;

- dwelling exchange list

- new housing calls for allocation

- booking service for dwelling exchange and sales

The access to BECA portal has been provided through the ATC web portal (already known to the tenants) instead of creating a new tool. In order to enable tenants of social housing to access to an ATC portal, it was compulsory to follow a strict procedure, as accessing to the reserved area of ATC portal may cause frauds (the ATC portal is linked to the main database that contains also sensible data). The above mentioned procedure previews, required the submission to ATC of personal information such as social security number, name and email address of the applicant for the service activation. In writing the letters to tenants ATC also included the option to replace the e-mail with the mobile phone number for those who do not have an e-mail account. It is in fact common to have a Smartphone more than computers at home.

ATC provided tenants with an initialization password that should be changed by the user after the first access and the user name was the security number of the tenant.

In 2011, it was possible to see only the monthly consumption, but in 2013 daily monitor of tenants' consumption (heating and hot water only) was made possible by ATC.

Tenants/users also received information on energy consumption in the bill (separate letter sent with the bill not directly on the billing certificate because it is impossible to change the format of the bill). Tenants were directly contacted in case any abnormal consumption was detected.

- (CASE 1) It was possible for all tenants, from the three pilot sites, to request information about the status of their consumption to the call centre by calling (tool already available for other users' needs). The staffs were trained to provide appropriate responses.

- (CASE 2) Installation of a computer station with connection to the web portal at the offices of ATC. Application was installed to control accesses the portal from that PC apart from the access provided at home for selected tenants. (1st phase).

- (CASE 3) Alarms. Users reported any anomalies on excessive energy consumption through the medium of communication preferred by the tenant (SMS later on, e-mail, phone call).

RMS – service description
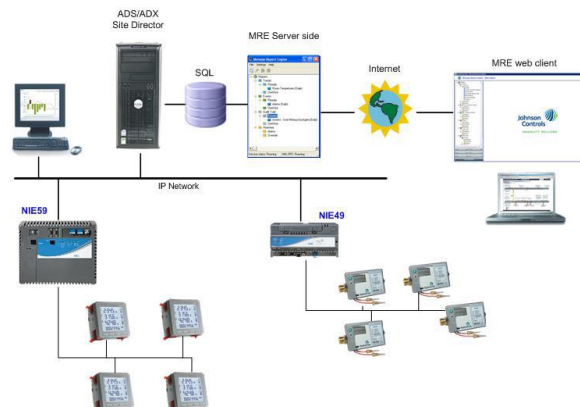
Orbassano (Techem)

- Activation of the reading system and remote monitoring of heating and DHW consumption for all dwellings (daily);

- Controls annual fuel consumption of heat generator for heating and domestic hot water;

- Annual inspection of the thermal energy delivered to the building for heating and domestic hot water;

- Optimisation of energy consumption for heating and domestic hot water by installing electronic devices (adapterm from Techem).

District MOI (Johnson Controls)

- Activation of the reading system and remote monitoring of heating and DHW consumption of housing (daily);

- Monitoring of monthly Cold Water consumption;

- Monthly control of thermal energy delivered to the building for heating and domestic hot water;

- Optimisation of energy consumption for heating and domestic hot water with a streamlined management of the plants through the Johnson Controls Metasys;

- Integrated Management of plants from a distance, through the supervision system of Johnson Controls Metasys with the possibility of sending automatic alerts to the manager.

District Spina 3 (Caleffi)

- Enabling remote reading system, and daily monitoring of the joint consumption of heating and DHW;

- Monthly control of thermal energy delivered to the building for heating and domestic hot water

Quantitative Analysis (CBA)

The path for socio-economic return is almost steadily increasing and mostly driven by savings by *Tenants*. Since the site is large, certain costs are distributed across many dwellings (compared to other sites) leading to immediate pay-off. The benefits for the *Social Housing* provider are resulting from administrative and organisational improvements of which only measurable items (no estimates for overhead) have been included in the calculations. The *Tenant* has almost no cost: A fee for the service (if legally possible) could shift some benefits enabling further deployment in other dwellings. As the installed solutions vary (across Torino sites), only half the potential savings for heating have been used in the CBA. On the other hand, development cost for the portal is not included as this is to cover larger parts of the building stock in the future.

Total Socio-Economic Return

Value Propositions

The key strength is the ability to handle data coming from various building management systems which are not directly compatible. BECA is not only able to handle and visualise the data but also to understand any differences arising as a result form different standards / methods used. The tool serves professional users as much as it serves tenants. Professional are provided with one platform for day-to-day monitoring, central setting of standardised alarms while being able to dig deeper in the designated building management system on the same desktop. The centralisation is cutting overhead and response-time and improves motivation to find ways to optimise systems further as a wide range of tasks does no longer need to be repeated. In this context, it also provides the housing company with one central platform to communicate with tenants. Tenants are now able to monitor their consumption and communicate any technical problem via the platform. By adding transparency, BECA helps to ease the difficult relations between the social housing provider and the tenants, especially in cases of high consumption detected. Finally, one energy management system was upgraded with Adapterm improving energy efficiency.

Future Exploitation

BECA enables ATC to standardise energy consumption data collection in a more efficient manner across the entire building portfolio of all developments capable will be integrating in the system in the near future. Upcoming energetic retrofitting programs will include more versatile technology capable of further integrating the BECA solution for tenants and professionals. The transparency enabled by BECA and the tenant platform will be exploited across / between departments. Finally, 30 data loggers are being monitored by PoliTO to research opportunities for future improvements.

ATC[5] is communicating with numerous housing (especially in the North of Italy). The goal is not only to provide the companies with the solution but to also standardise certain procedures across participants (e.g. billing measures) adding value to BECA while providing various other benefits creating massive overheads in housing companies.

---

[5] With regard to ATC Torino it is necessary to remark that ATC, being a statutory body, cannot derive economic benefits (in terms of profit) managing real estate of social housing in the Province of Turin. ATC Torino operates with the assistance of five in-house firms including a software services provider and an energy services management company.

3   Impact

This chapter describes the impact of the BECA project also quantifying various aspects relevant for further exploitation. To standardise the results and to make the calculations retraceable, assumptions are kept as simple as possible. Calculations are based on the figures collected as part of evaluation and the exploitation planning.

3.1   Environmental impact

Normalised values (per dwelling) enable the reader to easily extrapolate saving potentials to the size of developments (or regions) they are interested in. The values in this section have been calculated in a way preventing any single observation to take a larger role than others.

Averages have been calculated as follows: The total savings for the entire pilot site has been divided by the number of dwellings covered hereby ensuring that all dwellings, independent of location, have the same weight. At the second step averages are taken across pilot sites divided by the number of applicable sites.

3.1.1   Resource savings

With an overall saving of heating energy consumption of 15% across all pilot sites the BECA project met the target. This presents a significant achievement considering the outstanding importance of reducing energy use for domestic heating, which accounts for more than two third of energy consumption in the residential sector.

For the resources covered by the majority of sites savings of 15% for heat energy, 11% for cold water and 17% for hot water have been achieved. Only for electricity the target was not met (2%). However, it has to be taken into account that the most effective way to achieve meaningful electricity savings is to replace old electric appliances by new and less energy consuming ones. The tenants of social housing often do not have the means for doing so and assess it as not useful to replace appliances when the old ones still work well. As all pilot sites will continue the provision of their services they can base their future campaigns, energy coaching and further activities on the current success of the project.

3.1.2   CO$_2$ savings

With respect to the BECA project as a whole, about 177 tons CO$_2$ emissions could be saved which confirms the great success of the services.

Exhibit 10 - Overview of global results including calculated savings (pre-post comparisons of exp. groups) and reduced Co2-emissions

Site	Energy type	Savings target in %	Achieved global savings in % (eeMeasure)	Pilot dwellings with savings in %	Reduced CO$_2$ emissions in kgCO$_2$
Belgrade	Heat energy (RMS+RUAS)	15%	3%	n/a	76
	Cold water (RUAS)		16%	n/a	n/a
	Electricity (RUAS)		4%	58%	7,891
Darmstadt	Heat energy (RMS+RUAS)	6-10%	20%	82%	54,683
	Cold water (RUAS)		7%	56%	n/a

	Hot water (RUAS)		1%	53%	n/a
Havirov	Heat energy (RUAS)	5%	2%	90%	1,643
	Cold water (RUAS)	20%	3%	57%	n/a
	Hot water (RUAS)		1%	66%	n/a
Manresa	Heat energy (RMS+RUAS)	20%	6%	61%	1,513
	Cold water (RUAS)		5%	59%	n/a
	Electricity (RUAS; incl. Peak demand reduction)		increase: 5%	39%	increase
Örebro	Heat energy (RMS)	4-6%	19%	n/a	93,780
	Cold water[1] (RMS+RUAS)	22%	37%	86%	
	Hot water[1] (RMS+RUAS)	7%	35%	86%	
Ruse	Cold water (RMS+RUAS)	10%	8%	62%	n/a
	Electricity (RMS+RUAS)		6%	56%	6,477
Torino	Heat energy	6-10%	Orbassano (RMS+RUAS): 6% Spina 3 (RUAS): 0.4% MOI (RUAS): 7%	Orbassano: 56% Spina 3: 53% MOI: 67%	2,900 (Orbassano, Spina 3) 7,650 (MOI)
	Cold water (RUAS)		1%	51%	n/a
	Hot water (RMS+RUAS)		31%	87%	n/a
Total				39%-87%	177 tons

[1] In addition to RMS and RUAS a new billing system was introduced where costs are now calculated according to the actual consumption of dwellings (before the water consumption expenses were included in the rent)

3.1.3   Pilot overview and comparison

There are differences in the savings across pilot sites illustrating the importance of individual contexts, conditions and dispositions in the national societies for the achievement of savings. With respect to heat energy consumption the pilot sites at Darmstadt and Örebro achieved the highest savings of 20% and 19% which is mainly due to using RMS which automatically optimises the supply water temperature in the case of Darmstadt and sets the indoor temperature at a maximum of 21 degrees Celsius at Örebro. Related to cold water consumption Belgrade and Örebro achieved the highest savings of 16% and 37%. These high savings in Örebro are at least partly due to a specific condition introducing a new billing system with now water expenditure calculation on the basis of the actual consumption of the tenant households. This made tenants very responsive to the RUAS services. At Belgrade the experimental group tenants showed a remarkable increase in their subjective energy saving norm, therefore felt responsible to save energy and improved their behaviour related to water consumption. The highest reduction of hot water achieved again Örebro due to the above mentioned reasons (35%) and Torino (31%) where the mainly elderly tenants with low pensions have been highly motivated to save money. Regarding electricity consumption that was part of the project at three pilot sites, Ruse achieved the highest savings with 6% by targeting high-consumers with additional coaching.

While drawing conclusions largely varying conditions need to be considered as the local context might have varying influence across pilots. Nonetheless, results suggest that RMS generally is

more effective than RUAS. In that context one important advantage of RMS is that its effects inure to the benefit of whole buildings. As a consequence the optimal service setup seems to be the provision of combined RMS and RUAS which can bring out the potentials lying in optimising operations of buildings together with optimised user behaviour. This was also shown by a building-specific analysis on heat energy consumption. Furthermore RMS technologies that automatically regulate energy related features (such as Techems' adapterm or setting a limit room temperature) seem to have a bigger impact than systems that serve as monitoring instruments for detecting malfunctions.

3.2　Economical impact

Results collected are based on a standardised calculation of Cost and Benefits using a comprehensive Analysis tool (CBA) differentiating multiple stakeholders. The tool allows for modelling various installation variants and cost distributions at pilot level as well as projection of costs and benefits. The tool allows for modelling distribution of costs and benefits among the eight relevant stakeholders identified (by changing the share of individual indicators paid / received). This enables all stakeholders to agree on a common (or design an individualised) business plan. The benefit of BECA is calculated as the difference of all costs and benefits for BECA subtracted by all costs and benefits of the status quo ('Do nothing' scenario).

Results are bases on calculations for a period of 10 years and will be normalised for a set of 1,000 dwellings assuming a representative distribution of qualities along various dimensions (e.g. insulation standard of buildings, capability of tenants to save energy). Results presented are net present values assuming 5% interest rate for financial cash flows and 3.5% for intangible benefits. This approach allows for simple and straightforward extrapolations to the relevant level of social housing companies, regions and the EU.

The socio-economic return is presented for the entire pilot site. It has to be pointed out that the vast majority (95%-100%) of indicators used are directly linked to cash flows and only a small number of indicators are intangibles measuring societal benefits.

3.2.1　Project benefits

In total, the BECA project will create a net benefit of €1.7 Million over a period of 10 years. The sum is likely to increase with increasing prices of resources such as electricity and gas. Moreover, companies exploiting the solution are likely to collect further benefits with economies of scale and further experience on how to best and quickly educate tenants.

More detailed values can be found in section 4.2 describing the overall business case for ICT-based energy efficiency measures.

3.2.2　Pilot benefits

Depending on the setup, more or less functionality is offered to either the tenant, professionals or as an automated system. Degree of functionality correlates with technical requirements and costs. This correlation is particularly strong for implementation costs but also holds for operation costs since financing the investments is often based on future payments. In many pilot sites BECA does not only add benefits through energy savings but also in the operation of the service itself, by either optimising processes or allowing for revenue streams which have not been possible prior.

Total return on invest - all stakeholders in the pilot site together - is reached across all sites within a few years. This does not imply that an individual stakeholder might require a few more years to get investments back. In fact, some service providers need longer especially if they enter the market as 'newcomers'. Moreover, some social housing providers offer the service to reach a wide range of societal goals (e.g. reduced energy poverty, better relationships with tenants, and control over buildings), which cannot be sufficiently modelled in a cost-benefit analysis as they require long-term data for reliable calculations.

3.3 Societal benefits

Aside of purely environmental and socio-economical benefits achieved with the BECA service various societal benefits should be also considered as part of the contributions to society. Many users of BECA are elderly and / or receiving societal benefits. This part of the population is likely to have no access to and limited experience with the internet which – depending on the service design – is required to achieve the maximum impact. Examples given were partly developed as part of BECA.

3.3.1 Access to the internet

Some sites ensured access by implementing public access points (kiosks) to their tenants. In some cases these tenants have opportunity to also browse the internet as long someone is in the office.

3.3.2 IT-literacy

The BECA service helps to reduce existing barriers regarding IT-equipment and the internet experienced by elderly and others. This is achieved by educating users basic concepts of control, navigation and conventions used on tablets and PCs as well as in the cloud and on web sites.

For instance, in some cases the BECA service was presented to the tenants by energy coaches. Though this experience might seem limited it should be taken into account that these individuals would otherwise never collect the basic experience of navigation and translation of data into graphics based on their request and interest rather as an exogenously prepared document.

3.3.3 Empowerment and e-Inclusion

IT-literacy can be improved by empowering selected individuals to become local energy coaches who not only receive but also teach. ICT-based energy efficiency projects should consider selecting individuals having difficulties to enter the primary labour market due to long-term unemployment or disabilities as energy coaches fulfilling a central and socially valued role in their local community.

4 Exploitation

This chapter presents tools and results developed for exploitation. The focus starts on the guide for replication on stakeholder level over business plans that could create the paths for implementation.

4.1 Guide for replication

An extensive Guide to project replication is part of the Annex. The Guide presents the prerequisites of energy efficiency implementation using ICT. The main part presents the replication of BECA like projects along three dimensions:

- Timeline – which issues need to focused upon at which point in time
- Stakeholder – which stakeholders need to be involved in any given step
- Procedures – what steps need to be taken (e.g. using checklists)

4.1.1 Structure

The guide has the goal to support and enable housing organisations, utilities, IT-service providers and other key stakeholders to easily replicate and implement BECA services, tailored to their own needs and local conditions.
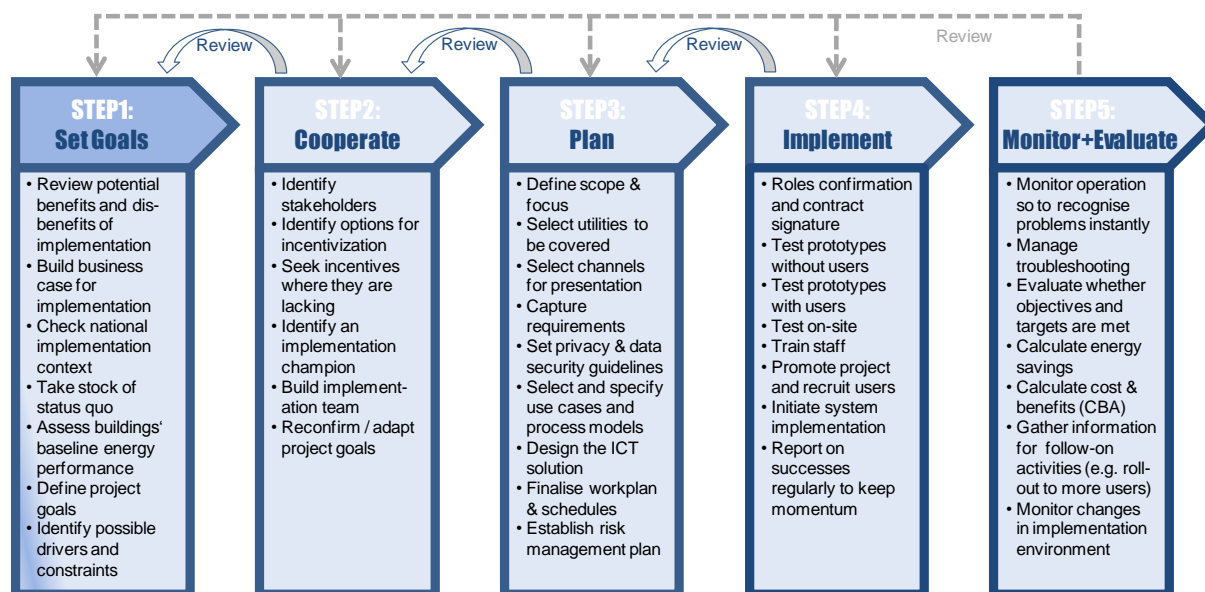
Exhibit 11 – Guide for replication

4.1.2 Steps for replication

The main part is made up by the **BECA Guide to Replication**. It leads readers through the major phases of an implementation project (see figure below). The aim here is to describe the full process of service introduction, including when to involve what kind of stakeholders for what purposes.

Exhibit 12 – Steps for replication

STEP1: Set Goals	STEP2: Cooperate	STEP3: Plan	STEP4: Implement	STEP5: Monitor+Evaluate
• Review potential benefits and dis-benefits of implementation • Build business case for implementation • Check national implementation context • Take stock of status quo • Assess buildings' baseline energy performance • Define project goals • Identify possible drivers and constraints	• Identify stakeholders • Identify options for incentivization • Seek incentives where they are lacking • Identify an implementation champion • Build implement-ation team • Reconfirm / adapt project goals	• Define scope & focus • Select utilities to be covered • Select channels for presentation • Capture requirements • Set privacy & data security guidelines • Select and specify use cases and process models • Design the ICT solution • Finalise workplan & schedules • Establish risk management plan	• Roles confirmation and contract signature • Test prototypes without users • Test prototypes with users • Test on-site • Train staff • Promote project and recruit users • Initiate system implementation • Report on successes regularly to keep momentum	• Monitor operation so to recognise problems instantly • Manage troubleshooting • Evaluate whether objectives and targets are met • Calculate energy savings • Calculate cost & benefits (CBA) • Gather information for follow-on activities (e.g. roll-out to more users) • Monitor changes in implementation environment

4.2 Energy Efficiency using ICT: The business case

This section aims to help the reader with decisions and estimations for further plans summarising the key results of the sections above as well as the Guide, evaluation cost-benefit analysis. Across all pilot sites the average benefit of an installation of 1,000 dwellings over a period of 10 years would result in benefits of €5.8 Million.

4.2.1 Benefits explained

The business plan for any given project determines which costs and benefits are directed to an individual stakeholder. The descriptions below describe the most typical outcome across the 7 pilot sites.

Implementation

Implementation refers to the phase in which equipment and the BECA solution is being installed. The costs occur once or in given intervals based on the life-time of, for instance, metering equipment.

Stakeholders benefiting at these stage are mostly those not financing the service but providing either equipment or services necessary to implement and operate BECA. Many of these companies are SMEs.

Operation

Operation refers to the phase in which BECA solution is being installed. The costs occur every year (shorter intervals are accumulated to a year).

Most stakeholders benefit independent of the business plan due to:

- Reduced life-time costs of equipment;

- Optimisation of internal processes due to IT-based infrastructure;

- Detection of faults and errors reducing, for instance, the life-time of equipment with sensors installed;

- Improved relationship with tenants reducing the cost of communication;

- Establishing a business case re-distributing some formerly consumption costs as an energy service.

Consumption

Consumption refers to the cost of all resources consumed in dwellings as well as in communal spaces. The benefits occur every year.

The payments for resources are often leaving the European economy as commodities such as gas, coal or oil need to be imported from abroad. Improving the energy efficiency, even if the full gain is not achieved in economical terms, reduces the need to import commodities. The funds not available to citizens are needed to finance enterprises – many of whom SMEs – to provide the service and hereby strengthening the European IT and service sector.

Value propositions for ICT-enabled energy saving services

This section summarises *key* value propositions for the BECA solution and the targeted stakeholders which have been developed in SWOT and CBA analysis and are being used in marketing and exploiting the BECA solution.

BECA overall

ICT-enabled energy services support stakeholders in:

- constantly reduce costs
- improve service performance and support
- provide rapid access to new technologies
- implement more complex applications
- demonstrate clear return on investment

Specific value propositions are:

- reduce total cost of ownership
- provide a predictable expenditure model
- deliver greater service performance
- introduce rigorous process efficiency
- maximize innovation and technological agility
- deliver transparent ROI

Tenants

- reduce cost of energy and water consumption
- reduce cost of network connection (e.g. fees for metering)
- reduction of energy poverty and dependence on state
- positive impact on environment
- positive feedback for own activity
- positive influence on behaviour and self awareness
- improved communication channel with social housing company

Social housing providers

- reduce cost of metering
- reduce cost grid connection
- faster detection of malfunctions
- future proofing for own energy provision (e.g. local storage)
- potential to market energy to tenants
- ICT integration of energy processes into management procedures
- facilitated communication between departments

IT-service and measurement providers

- innovative business model based on service and energy contracting
- reduce cost of metering
- reduce cost grid connection
- faster detection of malfunctions
- future proofing for own energy provision (e.g. local storage)
- integrated data collection for further analysis (e.g. big data)

4.3   Exploitation scenarios / Business Modelling

Each exploitation scenario is structured so that it firstly introduces key challenges and incentives for the leading stakeholder followed by generic business cases which can be easily matched against the reader's preferences and opportunities.

The driving stakeholders are likely to be the investing party but it does not imply that these are also the 'net payers' in the early years of the investment. In fact, the driving party is usually shaping the business model for BECA services and therefore has the option to control some of the cash flows and revenue streams by matching it with their own strategy while ensuring that the customers collect benefits through the service offered.

One underlying assumption applies to all business models: ICT-based measurement (smart metering) is no business model on its own but no new business model is thinkable without smart metering.

This section cannot replace detailed lessons learnt for individual stakeholders which are listed in the 'Guide for Replication'.

4.3.1   Driven by Public institutions

Institutions in question can be social housing companies (and e.g. universities offering housing for students) having numerous incentives to reduce energy costs of their customers and public bodies such as municipalities or regional governments pushing for a strategy to reduce the cash flow going from the public pocket straight to utilities.

Innovative social housing companies have the option to extent BECA services not only in energy fields but to make dual use of devices such as communication infrastructure and sensors. Similar technology is needed to offer services such as independent living (elderly) or Telemedicine / eHealth (e.g. chronic diseases) supporting tenants in need of assistance. These innovations could allow tenants to live longer in social housing and is likely to reduce risks for all parties involved.

Possible strategies

- RUAS can be offered as a service to the tenants ensuring that they are enabled to save energy in the short term but it also suits several long-term goals. With energy costs increasing, fixed costs become a larger and larger part of any household's spending. This might lead to costs of energy competing against the costs for living and hereby delaying payments. To avoid expensive cost claim procedures it is in the housing company's interest to keep the share of variable costs as low as possible. These investments can also be used to redefine the relationship with tenants and to empower them, an opportunity described in more detail below.
- RMS services are not only successful in reducing the costs of energy but also in reducing the need for and the costs of maintenance - a factor not sufficiently covered in the cost-benefit analysis. The cost reductions start with quicker diagnosis of, for instance, boiler and heat distribution systems. Moreover, administrative processes can be digitalised along the entire chain making the offices more effective.
- In general, concern about rising energy costs is shared among all tenants, which in turn creates an opportunity to empower tenants. This can happen either by strengthening the

community within buildings and sites or by providing services to the tenants they probably had no access to yet. Low income households and elderly are the most likely not to have any access or knowledge about the internet. When equipping the buildings with ICT it could also be considered to offer internet access which could trigger not only further optimisation of administrative processes (e.g. all tenants using web forms rather than paper) but also many other socio-economic benefits.

4.3.2 Driven by Market 'Newcomers'

The companies in question should not be confused with start-ups. Various companies have been offering related services for decades. The focus is rather on innovation SMEs pushing ICT solutions into markets where the established market players are less innovative and prefer to remain with analogue or similar technologies. Newcomers often have to make high up-front investments bearing the risks

Although no rule in itself, it can be assumed that these newcomers are mostly active on regional markets even to the degree of reaching market leadership for a selection of services within this market.

Possible strategies

Newcomers often offer tailored services reaching beyond measurement or RUAS services as such but involve either integration into existing administrative processes or complex RMS services including also supply-side and / or distribution management. Since the service often covers new areas high investments up-front are necessary which are covered for by the newcomers taking on a large share of the risk.

- RUAS can be offered either as a highly innovative system to be quickly deployed or it can be seen as a complement to the RMS installed in the first place. This either fully utilises all hardware installed for RMS or it enables the RMS service to run at full capacity and optimal level as the hardware installed for RUAS provides the necessary data.
- RMS services are often offered as tailored solutions for the heating systems in place or in combination with a full replacement making the social housing company independent of utilities by producing their own energy using biofuels or gas. Alternatively it can be a highly scalable and flexible solution for optimising back-end processes such as billing to which the customer can opt-in bit by bit rather than investing high amount up-front. Often the risk of investment is covered for by the newcomer.
- In general, an advantage of small companies is the ability for energy contracting and other forms of delayed payments since the accounts of public bodies often do not foresee unscheduled investments in technology.

4.3.3 Driven by established Market Players

It has been observed that many established market players (especially utilities) are not yet willing to change their business model and to adopt ICT-based measurements of electricity, heating and water. Whatever the reasons for this reservations (some of which are described in the first section of this chapter) those leading companies pushing for ICT-based services have to be identified as key drivers of smart metering.

The immediate impact of company strategies will widely distribute the awareness of smart metering as an option and the BECA service as a suitable add-on for ICT-based measurement. Moreover, the market power and demand for infrastructure required (e.g. concentrators and gateways) is likely to drive competition and innovation in this field. This is less likely for metering equipment as this is more likely to be tailored for specific needs in such large numbers.

Possible strategies

Given the size of the companies it has to be an upgrade of existing business models. This implies modernisation and digitalisation of existing infrastructure, in this case predominantly the measurement of consumption. However, additional revenue streams are possible with the data collected:

- RUAS as a service for customers such as tenants who not only benefit from the ability to better monitor and reduce their consumption but also improved administrative processes such as more frequent and / or faster billing and closure of contracts (e.g. moving to another dwelling).
- RMS for large consumers or those in the need to maintain and monitor production sites. For the moment this is mostly limited to heating boilers and renewables but in the near future combined heating (cooling) and power plants could be included.
- In general, costs of administrative processes can be reduced throughout the lifetime of a customer relationship while establishing a new permanent channel providing the opportunity to market not only resource provision but other services that can be hosted on the same platform such as smart home, entertainment and potentially other products.

5 Conclusions and Recommendations

Following the structure of the document numerous key conclusions from the project are drawn. Each conclusion is accommodated with recommendations on how to achieve the particular result or correct a certain development, respectively. Fundamental steps are being referred to listing selected lessons learnt from section 2.

5.1 BECA solution

The BECA solution can be applied in all circumstances

Social housing companies usually have a highly diversified portfolio of buildings. Heat production, for instance, might range from electricity heaters in each flat to CHPs in a local district heating grid. The need to design different IT-solutions from scratch would imply higher costs and increase the risk of incompatibility. The BECA-solution proofed that standardising requirements (WP1), use cases / process models (WP2) and architecture (WP3) to the wide range of pilot sites is possible and successful. Following the BECA guide (see Annex) ensures that the necessary steps are taken during the design stage and the solution is capable of future extensions. The guide structure is an optimised version based on the work programme which has proven itself in ten different pilot sites.

Recommendation: Use the BECA Guide for Replication to plan your smart-meter based energy efficiency project.

RUAS Best Practises for deployment to social housing tenants

Within RUAS, using paper reports or offering a service hotline and coaching to tenants in addition to the web-based services are important. This is demonstrated by the fact that tenants of the experimental group who did not became active portal users also achieved meaningful savings (e.g. in Belgrade or Havirov).

RUAS can be considered as useful instruments for the achievement of durable reduction of energy. At all pilot sites tenants show an increased ecological awareness. The same applies to the ecological behaviour of tenants becoming apparent also for resources not addressed with the BECA services. Such spill-over effects indicate that when tenants started watching out for their ecological behaviour, they do so in all domains of energy use.

Recommendations: The heat energy consumption was mainly influenced by turning off the heating when opening windows and turning down the heating when leaving the home for a longer time. Warm water consumption has been reduced by using cold water for washing hands and taking a shower instead of a bath. With respect to electricity consumption, to mind the energy consumption when purchasing new appliances showed the strongest influence on electricity consumption among the everyday practice related to electricity consumption.

Innovative features considered successful include the 'character' BECO (Manresa) increasing attention to the project and forecasting of costs based on the energy consumption of the households (Örebro).

RMS / RUAS help to maintain infrastructure while reducing resource consumption

The implementation of energy management system is mostly originally considered as means to optimise future production of heat (electricity and hot water) and detect and wastage. Yet, most sites were surprised that with the installation of metering systems various issues with present equipment became apparent. For instance, solar thermal installations did not provide the heat anticipated due to a minor hardware fault; a boiler supplying numerous buildings was re-starting itself over 200 times a day not only wasting large amounts of gas but also reducing the life-time of equipment. Nobody knew when the issues started and either example could only have been

detected if a person were present looking out for very specific piece of information. Metering and logging consumption (together with variables such as temperatures) simplifies detecting defaults which can trigger specialised staff to visit the site and check the systems. In turn, RMS and RUAS also reduce operational costs such as maintenance together with increasing energy efficiency.

Recommendations: Integrate energy efficiency projects with processes to maintain and operate infrastructure remotely. Combine system testing and implementation with an intensive phase of validation and error detection involving the experts responsible for the sub-systems.

RMS to collect low-hanging fruit quickly – RUAS for long-term strategies and benefits

Energy management systems (RMS) are able to quickly detect any occurring wastage or defaults which lead to inefficiencies – based on observations during the project either occurs on regular bases regardless of system infrastructure or age. Providing automatic alarms through RMS, there is almost no delay with reference to the flow of information. Automated alarms are easy to generate since there is an ideal state to which system can be optimised to. Moreover, since the responsible staff has sufficient experience, workers can be deployed to the site and fix the issue with little delay.

The situation for resource awareness systems (RUAS) is much more complex. Occupation and tenant's habits in each dwelling are likely to be different so automated system are more complex and likely to misinterpret situations. Even if alarms are possible high frequency can lead to users ignoring the system. Without alarms users need to visit the portal in order to learn about current waste or inefficiencies. Hence, there will be mixed success in the early stages: 'Champions' will start using the system quickly and start saving energy while others will need time to adjust to the new technology.

Recommendations: Concentrate first efforts on management systems, and focus first on buildings and systems that use the most energy. Use the savings to invest in awareness raising measures and systems based on direct feedback, which will need longer to pay themselves off because of the need of tenants to adapt their behaviour. In the case of investments both for immediate and longer-term energy efficiency improvements, involve as many of the key stakeholders as possible to be able to push the solution forward in one go. This will also help detect those who can disseminate and explain the solution to others (multipliers) as well as those who require additional help.

5.2 Approach and results

Digital services need to be promoted offline: Advice given by trusted intermediaries is crucial for widespread success

Web-services do not advertise themselves and are unlikely to be utilised by individuals with low IT-literacy or low incentives without promotional efforts – even if tenants pay their energy bills themselves. The service and its benefits need to be communicated and advertised offline. Human contact is most effective in explaining how the service operates or what its advantages could be for each single tenant. Locally active energy managers and social workers in particular are especially important when the service starts to become operational. These can be supported by 'champions', i.e. fellow tenants who show a strong interest in technical and energy-saving matters and who can act as multipliers by "spreading the message" and helping neighbours in case of questions.

Recommendations: For a successful implementation, a well-designed communication and information strategy is essential. This should make good use of multipliers, i.e. intermediaries and fellow tenants who can help promote the solution based on an established trust relationship with tenants. Make sure to establish transparency about timing; make tenants accustomed with the devices and services to be implemented at an early stage, and respond as much as possible to suggestions made by users. It is also important to keep up awareness raising activities over a longer period, preferably by embedding BECA implementation in long-term activities for saving

energy and reducing costs. This will prevent that the effect of raised awareness about energy efficiency will to die away quickly.

5.3 Impact

ICT of particular importance in well insulated buildings

In the socio-political and the scientific discourse about the possibilities to achieve energy savings in the domain of public and residential housing, regularly the question arises as to the influence of building-types on the impact of energy saving measures. This is an interesting question also for the BECA services. Although not being in the focus of the project, an analysis related to heat energy showed that for buildings where RMS and RUAS are provided the savings potential is higher for buildings with rather high energy performance (low heat energy consumption during baseline period) and is lower when the energy performance of buildings is rather poor (high heat energy consumption during baseline period).

Recommendations: Tenants must be made aware that living in a well insulated building does not automatically lead to low energy cost. In fact, their behaviour is of even greater importance: Speaking in relative terms of total consumption, leaving a window open does more harm in well insulated house. Smarter energy behaviour is also relevant in economical terms as the cost for insulation have already been paid for. Not fully "utilising" the insulation implies delaying the return on invest. BECA services are a cheap way of detecting wastage, giving advice and pointing at the tenants who might require additional energy coaching.

Influence of billing system on environmental behaviour

One more important program-external context factor important for the achievement of savings and the potential for the improvement of ecological behaviour of tenants is the billing system used. The saving potential is particularly high when the billing system is changed in conjunction with the service operation from expenditure calculation on the basis of square meter or a billing system with a fixed rate included in the rent into a calculation on the basis of the actual consumption of the households (as in Örebro). We identified that the potential is also high in cases where the energy consumption calculation had already been based on the individual consumption of households prior to service operation. In these cases the tenants are much more motivated to change their behaviour and try saving energy (this could especially be observed among high energy consumers such as in Ruse) than in pilot sites with a billing system based on the size of the dwelling instead of real consumption (e.g. Havirov, Belgrade).

Recommendations: Should individualised billing not yet be the standard, deployment of BECA services are an opportunity but at risk of being blamed for increased cost. Tenants learning that the billing system will change expect costs to rise – for some it will as, so far, the tenants often have only paid an average. Hence, the deployment of individualised meters and the BECA system must be communicated early on. It should be made clear that the housing company is providing the tenant with a service to help him/her reducing the cost. Otherwise, the housing company (and the BECA service) will be blamed for being the messenger. Should the housing company and / or service provider not have sufficient communication capacities, the following can be considered: Deploy user-facing services with a delay after the first bills have been send to the tenant to make these two events independent from one another.

Environmental and societal benefits complement one another

Only tenants who have good online access and feel confident in using online services can make full use of RUAS type feedback on energy consumption. There is a case, therefore, for efforts to boost digital literacy and internet access as these will increase people's capability to gain awareness about energy efficiency and to adapt their consumption behaviour in the most effective way. For this purpose, implementation of BECA opens up new possibilities: Implementing energy efficiency using ICT requires infrastructure capable of communicating with devices in the entire building. This infrastructure can easily be used (without much increase in cost) for offering wireless

internet access to tenants, as the BECA pilot site in Westerlo proved. There are clear indications that addressing the risk of fuel poverty and reducing 'digital divides' have similar requirements, and should best be tackled jointly.

Recommendations: If your preparatory investigation shows that a significant share of tenants do not have internet access or lack the digital skills to are likely to make good use of online services, consider providing all tenants with access to the internet e.g. by setting up a public Wi-Fi infrastructure. Experience shows that the additional investments required are low because of the infrastructure being implemented anyway when rolling out the smart metering system. By getting acquainted with online services, tenants will obtain digital literacy which in turn will enable them to better utilise RUAS-like web-portals and online feedback for optimising energy efficiency. Depending on the end devices you plan to use for displaying RUAS information, it may also be worth considering supplying tenants with tablet computers, which will also work as incentives for participation in an energy efficiency scheme.

5.4 Exploitation

BECA solution is viable with return on invest achievable within a few years
In total, the BECA project will create a net benefit of €1.7 Million over a period of 10 years. The sum is likely to increase with increasing prices of resources such as electricity and gas. Moreover, companies exploiting the solution are likely to collect further benefits with economies of scale and further experience on how to best and quickly educate tenants.

Total return on invest - all stakeholders in the pilot site together - is reached across all sites within a few years. This does not imply that an individual stakeholder might require a few more years to get investments back. In fact, some service providers need longer especially if they enter the market as 'newcomers'. Moreover, some social housing providers offer the service to reach a wide range of societal goals (e.g. reduced energy poverty, better relationships with tenants, and control over buildings), which cannot be sufficiently modelled in a cost-benefit analysis as they require long-term data for reliable calculations.

Recommendations: In spite of the economic benefits to be gained, implementation of smart meter enabled energy efficiency and demand response services requires a well prepared promotional strategy to win over all stakeholders. These should place emphasis on the benefits to be derived in terms of financial savings on the part of tenants, housing companies and energy providers and in terms of convenience and self-determination on the part of tenants. Seek for early information and full transparency; any concerns voiced by tenants should be taken seriously.

Successful incentivisation of all key stakeholders is a major criterion for success
Obtaining buy-in and active support from key stakeholders is of essential importance for any project for exploiting the potential of smart metering for improving energy efficiency in social housing. Relationships between stakeholders and the business model should be agreed early on, with a focus on incentivisation of all partners, i.e. making sure that all participating stakeholders perceive a tangible benefit from the implementation. The main challenge here is divergence between investment needs and the financial benefits to be derived: In many energy efficiency projects in the housing market, there are some stakeholders financing the installation, others who pay for operation and others again who derive financial benefits, e.g. because of their ability to charge customers (e.g. tenants, local administrations) for the upgrading of the housing stock.

Recommendations: Do not take implementation decisions before the business model has been agreed between all key stakeholders. Openly discuss incentivisation and seek to avoid a situation where positive decisions by a stakeholder depend on the personal opinion of individual decision-makers. In case of doubts about the commitment of a key stakeholder, consider financial compensation or innovative schemes for revenue-sharing.

European standards for exchange of metering data are required

In many cases the measurement provider is not necessarily the party offering the BECA service. Any successful deployment of BECA services will often require exchange of data between different stakeholders. Yet, technological approach and different data storage concepts can hinder short-term automated data transfer. Moreover, the experience in this project shows that utilities can suddenly limit access to data. Reasons could be the danger of privacy related law suits or to protect the existing business model among other.

Recommendations: Standard procedures for data exchange are still mostly limited to instances where the customer changes suppliers. Introducing a European body to certify equipment and to harmonise regulation on server based data availability to ensure a common European market.

6 ANNEX

6.1 'Guide for Replication' as separate document