EEPOS - Energy management and decision support systems for energy positive neighbourhoods

Co-funded by the European Commission within the 7th Framework Programme.
Grant Agreement no: 600050.
2012-10-01…2015-09-30 (36 months).

EEPOS End-User Collaboration Tool Specification Report

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1. PUBLISHABLE EXECUTIVE SUMMARY

This reports is the specification report of the task for end-user collaboration tool. The purpose of the report is to describe the path how the scenarios and technologies can form the collaboration tool as well as how the collaboration tool is intended to use.

To this day the **currently used information systems** are based on technology driven development. The developed information systems use state of the art technology and operate technically well, but are not well taken in the use by the end-users, because they are not very user friendly and do not have features supporting user engagements. However, it is estimated that energy consumption reduction of up to 15% can be achieved through improved **user awareness**. However, present technology gives an opportunity to use the EEPOS demonstrations as a playground for End –users to **join the big picture** as active players.

The scenario text like following quotation are to be tested in practice: *"Heikki is a resident in the EEPOS neighbourhood. He is an average citizen who has some interest for energy saving issues but he does not know how to do that. Fortunately a new EEPOS end-user collaboration tool has been developed. After few short information sessions all EEPOS neighbourhood residents have been informed how to use the tool."*

The technical and functional requirements are presented from a slightly different starting point of demonstrators, thus forming a bigger variation of things within demonstrators.

The EEPOS platform developed in task 3.3 (based on OGEMA) is the foundation where the User collaboration tool is based. The Demonstrator-specific metering and sensors are linked to the system. The End-user interface will combine both information and experiences from previous projects and test it in the interface made with Unity game engine. The default browser interface (PC) can also transformed to a mobile Apps covering iOS and Android

2. Introduction

2.1 Purpose and target group

This report is the natural continuation of the reports in work packages concentrating to the end-user tool specifications. The purpose of the report is to describe the path how the scenarios and technologies can form the collaboration tool as well as how the collaboration tool is intended to use.

The target group is naturally the project partners report being a repository of the further planned actions in coordination to the technology available. The demonstrators are the practical drivers for all actions having a set of technological and functional requirements.

This report of Task 3.4 is the starting point (M12) of actual activities in demonstrators and will lead to the comprehensive documentation report of the End-user collaboration tool in M23.

2.2 Contributions of partners

The development of the End-user collaboration tool starting from scenarios (D1.1), stakeholder requirements (D1.2), architecture (D1.3) and technical description (D3.1) is an challenging process to fit into the EEPOS project targets.

VTT as task leader is responsible for the general content and the country (Finland/ Germany) demonstrator contributions was per country and parallel in this report. The structure and content of the document is to fill both the overall structure of EEPOS as well as the individual needs of the demonstrators.

This report is the specification part and will be followed by documentation report.

2.3 Baseline

- To this day the **currently used information systems** are based on technology driven development. The developed information systems use state of the art technology and operate technically well, but are not well taken in the use by the end-users, because they are not very user friendly and do not have features supporting user engagements. However, it is estimated that energy consumption reduction of up to 15% can be achieved through improved **user awareness**.
- **End-users** have been envisaged to **take actively part** to energy saving in the built environment. However the technology (simple enough / price for anyone) has been at least one of the hinderers for usage.
- At the same time as technology starts to be usable and accessible for anybody the **gaming** industry, for instance, have been actively developing as well as the **social media is used widely.**
- Hence, present situation gives an opportunity to use the EEPOS demonstrations as a playground for End –users to **join the big picture** as active players

"D1.2 :Stakeholder driven service-oriented information system that provides profound end-user motivation, "personal drivers" and understanding of energy issues."

2.4 Relations to other activities

The D1.3 (Platform Specifications) explains the End-user collaboration tool connection as a diagram with connections and EMS. The diagram is below.

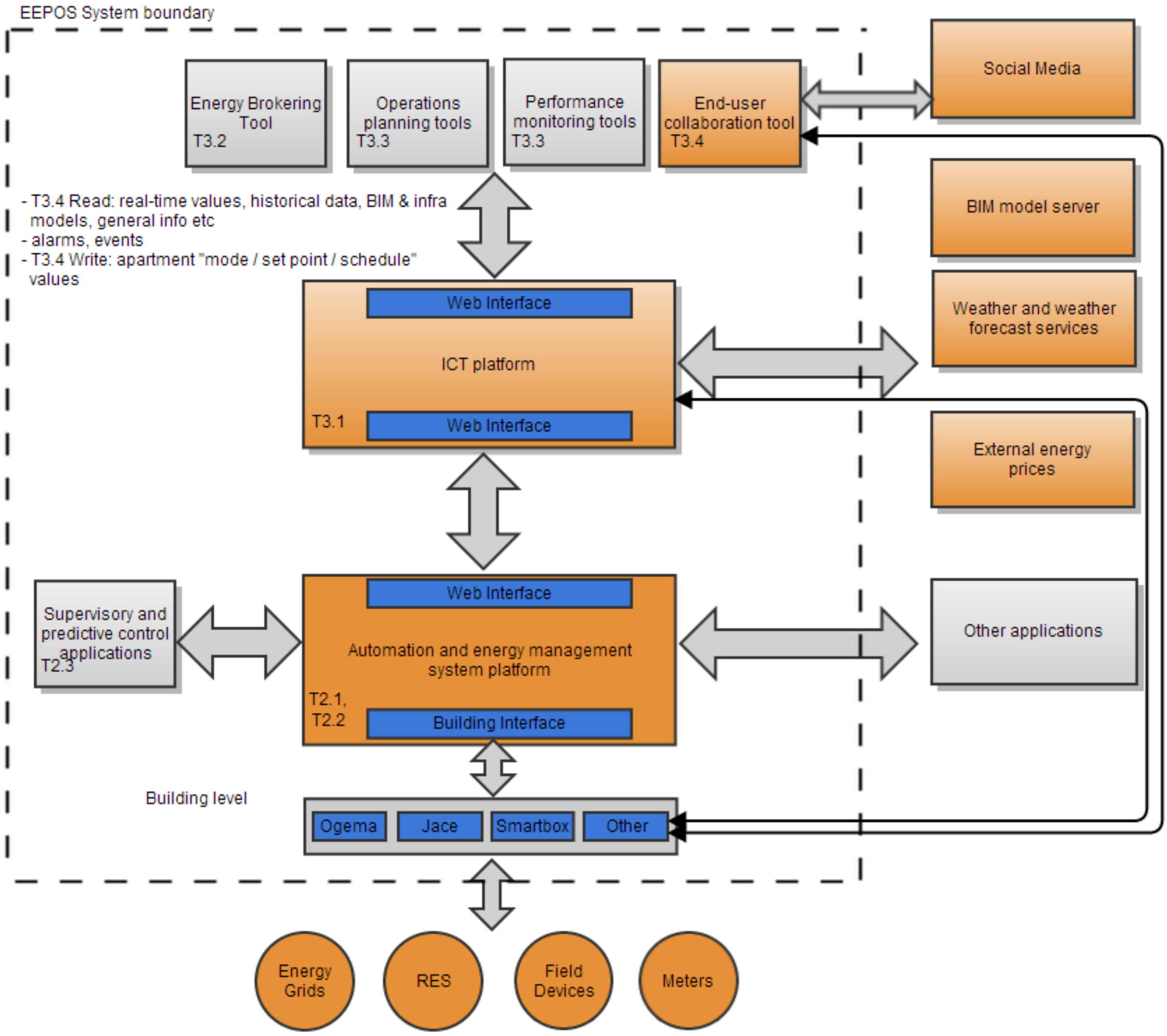

Figure 1. End-user collaboration tool diagram (from D1.3)

3. End-User Scenarios

3.1 End-user scenarios Finland

The scenario text example below is from a scenario called "End-user collaboration tool". All the scenarios are presented in D1.1 In this End-user collaboration tool task the scenario with same name is naturally the main scenario but also several other scenarios are tested to some extent at practical level with connections to each others

"Heikki is a resident in the EEPOS neighbourhood. He is an average citizen who has some interest for energy saving issues but he does not know how to do that. Fortunately a new EEPOS end-user collaboration tool has been developed. After few short information sessions all EEPOS neighbourhood residents have been informed how to use the tool."

"Heikki is just moved to his new apartment and he starts to use the tool. First he uses tool's energy reporting features including energy consumption (heat, electricity, gas etc.) reports, costs, RES part of the used energy and load shifting (moved demand from peak hours to off-peak hours of the day) relating year, month, day and hour level. The report includes also the comparison to the other end users consumptions. Using these reports Heikki has tried to save energy and do some manual load shifting. After two months later Heikki notices that he has been very successful in load shifting and he publish the result with few comments how to do that in end-user collaboration tool related forum. Later Heikki noticed that some load shifting could be done automatically and he order the work using the collaboration tool "work order" feature which send the order automatically first to the building owner (accept) and then to the NEMS operator (work order)."

The main scenario:

- Scenario B-4 (C3) : End-user collaboration tool

The Other Scenarios which are connected to the main scenario (described in the D1.1) and needed to meet the practical e.g. technical needs are following:

- Scenario B-2 (C1): Optimisation of HVAC system

  In this scenario end-users can set (can accept proposed limits) suitable limits for indoor climate conditions to be compromised to cut the peak loads and thus contribute to optimum heating and power grid utilization.

- Scenario B-3 (C2): Activities delayed/scheduled by end-user

  Based on the information and suggestions made by EEPOS software the end-user can choose to delay one or many energy consuming activities.

- Scenario BN-1 (C2): End-user balance card

  End-user or resident can purchase a balance card to enable simultaneous energy production and consumption (act as a prosumer). In practice this is tested with the sea water cooling functions being an replacement of purchased energy.

- Scenario N-1 (C2): Automatic consumption cut off

  This scenario elaborates the potential of peak load cutting functionality without intruding the end-user comfort. The idea is to cut off such loads that do not necessarily affect the wellbeing of the end-user or limit their occupancy.

3.2 End-user scenarios Germany

The main functions of the EEPOS end-user collaboration tool are to engage and motivate the end users in energy saving and shifting their energy consumption from peak hours to off-peak hours of the day. The load shifting depends for example on the available production status and the level of the storage capacity of the neighbourhood's renewable energy sources as well as SPOT market electricity price. As such the following end-user scenarios will be tested in the German demonstrator:

- Scenario B-4 (C3) : End-user collaboration tool

The end-user will receive some kind of information platform, which is running e.g. on a Tablet-PC which gives him a number of information about the energy status in his home and in the connected smart grid. The end-user-collaboration tool shall also provide information and tips about energy savings and shall increase the participation of the tenant in the energy saving project.

Additionally, the following end-user scenarios could be tested at the German demonstrator:

- Scenario B-1(C1): Integration of Consumers / non-automatized loads

This scenario is related to the scenario B-3 (C2). The end-user will receive information from the EEPOS NEMS e.g. about energy prices and can shift the operation of his household appliances to a certain time. The decision to shift loads in the household may be supported also by an incentive system such as "Eco points".

- Scenario B-2 (C1): Optimisation of heating grid on building level

With the remote control of the DDC-regulation units of the building heating systems it is possible to optimize the regulation parameters of the heating system, based on information of the EEPOS system. The optimized control of the heating systems in the building and the heating units in the local heating plant will lead to energy savings, which will be calculated with the energy management software ennovatis Controlling.

Scenario B-3 (C2): Activities delayed/scheduled by end-user

Based on the information and suggestions made by EEPOS software the end-user can choose to delay one or many energy consuming activities. (see also scenario B-1(C1)

- Scenario BN-1 (C2): End-user balance card

End-user or resident can purchase a balance card to enable simultaneous energy production and consumption (act as a prosumer). In practice this is tested with a simulation of the solar energy production, using the database of the existing solar cadastre, which is provided for the demonstration site in Langenfeld, Germany.

- Scenario N-1 (C2): Automatic consumption cut off

This scenario elaborates the potential of peak load cutting functionality without intruding the end-user comfort. The idea is to cut off such loads that do not necessarily affect the wellbeing of the end-user or limit their occupancy. With the remote control of the building heating systems in the German demonstrator, this scenario can be tested on building level.

- Scenario N-2 (C2): Utilising energy performance and planning tool
- ✓ The ennovatis Controlling energy management software will be used to validate this scenario in the German demonstrator. The software provides the following functions: Data collection
- ✓ Data administration
- ✓ Data analysing
- ✓ Load profiles
- ✓ Forecasting
- ✓ Benchmarks
- ✓ Saving potential
- ✓ Web-based reports

4. Description of End-Users Technology

4.1 Finland

4.1.1 End-user interface requirements

Technical requirements

Prior to the EEPOS project, to be able to engage with end-users Caverion has set up online website for each housing cooperative. Metering data, contracts, bus timetables etc are accessible from there.

Consequently, the main technical requirement in Fin demo case is to provide all information through either this website or native application for mobile operative systems (android, iOS etc.).

Functional requirements

From Caverion point of view, we aim to create user-friendly and energy efficient living environments for the residents, thus our need for the EEPOS platform will revolve around making people's lives easier. The EEPOS platforms End-user collaboration tool should enable the neighbourhood form a collective community where the all participants are able to contribute to high energy efficiency, environmental way of living and maximum resource utilization. This means that the end-user collaboration tool could connect all residents with the system through a kind of 'forum square /market place' where the achievements of residents independently or collectively can be highlighted and discussed. It could provide a certain backbone for decision making regarding renovation, service and maintenance, refurbishment or service procurement issues, as well. There might be a certain kind of ranking competition listing the top 10% performers.

As a neighbourhood management system, this system should also provide capabilities for incorporating utility billing functionalities and act as a central database for important information regarding the neighbourhood and its principals, systems, agreements etc. It might offer a neighbourhood calendar function for people to mark up relevant events, plan maintenance operations etc.

In addition End-users should be able to set allowed indoor climate conditions that could be temporarily compromised in case of high energy prices.

For example

- The end-user might allow indoor temperature to drop from 22 to 20 centigrade during high market prices to reduce electricity costs and cut peak loads. The normal temperature conditions will recover automatically when power prices have come down to acceptable levels.
- The end-user can activate the 'away' mode, thus allowing indoor temperature to drop down to 16 degrees celcius until return time. The normal temperature is recovered within forecasted low market price/consumption hours.

- During hot season indoor temperature is allowed to rise until 28 centigrade and chilled mode is used outside of peak hours only

4.1.2 Social networking possibilities

As in nowadays communication it is fair to presume that at least a critical mass of the end users in the project use some of main social medias for example: Facebook, Google+, LinkedIn, WhatsApp, Twitter etc. The main reason (one of many) of people using social media is the simplicity of communicating by just a few clicks. The media itself takes responsibility of activating users by delivering various types of messages e.g. updates of your friends account or common area.

Hence, the End-user collaboration tool should be something that can be for instance easily linked to or embedded in a social media. Then the collaboration tool (or view of that or some results etc) can be further linked /shared/ liked.

However, the EEPOS End –User collaboration tool itself has a functions including Social networking.

4.1.3 Games interface, engines, platform possibilities

The Basic platform of EEPOS (based on the OGEMA) is a perfect platform for various Apps or connections in/out.

- Hence, the gaming interface can be a "real " gaming interface being just an App showing items/data via platform with an User-friendly manner.
- One of the worlds leading gaming engines UNITY (http:// http://unity3d.com) was discussed in the workshop. There is a possibility to combine the data (from meters), calculations (like energy usage per m2) and for instance the 3-D model of the building as well as the landscape model in one screen. VTT have made succesful tests and will offer a solution based on the Unity engine with a strong believe that the engine is one of the main gaming engines also in the future.
- Furthermore, once the "gaming interface" is developed for a default browser-type of use in computers it can also be translated in the form of mobile application (iOS and Android)

4.1.4 Others

- Currently we are utilising Caverions performance meters called 'Rami' which present different performance metrics to end-users of the buildings. Rami metrics weigh programmed technical system operation/energy consumption against realised performance.
- Caverion is able to provide IFC BIM models of the buildings in neighbourhood to be utilised in energy performance visualisation as well as gaming/competition purposes.
- Information platform for users (web portal)

At starting point of EEPOS project, all residential buildings built by YIT and the technical systems delivered by Caverion have its own tenant Web portal in use. The portal content is for e.g. user manuals, household meetings protocols, own apartment's room temperatures and water consumptions. In The picture below there is a screenshot of the existing Caverion Extranet .

Figure 2 Extranet Web portal for the real-estate company and apartment owners

4.2 Germany

4.2.1 End-user interface requirements

4.2.1.1 Technical requirements

As the user interface will be accessed by the end-user either with a Tablet PC and a wireless internet connection, or with a PC/Laptop connected by LAN cable it is one of the essential requirements to have a reliable and fast internet access and a fast responding device, because long loading times would decrease the interest of the user, which has a significant influence of the general participation in the project. At the demonstrator site in Langenfeld each dwelling is connected to a broadband TV-cable network, which provides also internet access and telephone services. To avoid any problems with misuse e.g. of a provided internet access by the project, it is necessary that each end user will provide his own individual internet connection, which are nowadays in most cases flat rates.

4.2.1.2 Functional requirements of the end-user interface

The design of the end-user interface is a very important point in the project, because the interface is the main utility for the end user, which gives him the feeling to be connected to the smart grid. The end-user shall see all information about his own energy consumption and energy production as well as other information about energy prices, tariffs etc. Ennovatis worked in the 3e-Houses project on the development of an “easy-to-understand” web interface, which was used by participating tenants in the 3e-Houses pilot and replicator in Germany. The general feedback of the tenants regarding the information content and the general functions of it were very positive.

The following Figures 3, 4 and 5 show as a visual example of the design of the used web interface in the German pilot of the 3eHouses project. Different types of web interfaces were also used in the UK and Spanish pilot of the 3eHouses project, whereat the UK approach was very artwork like and successful as well.

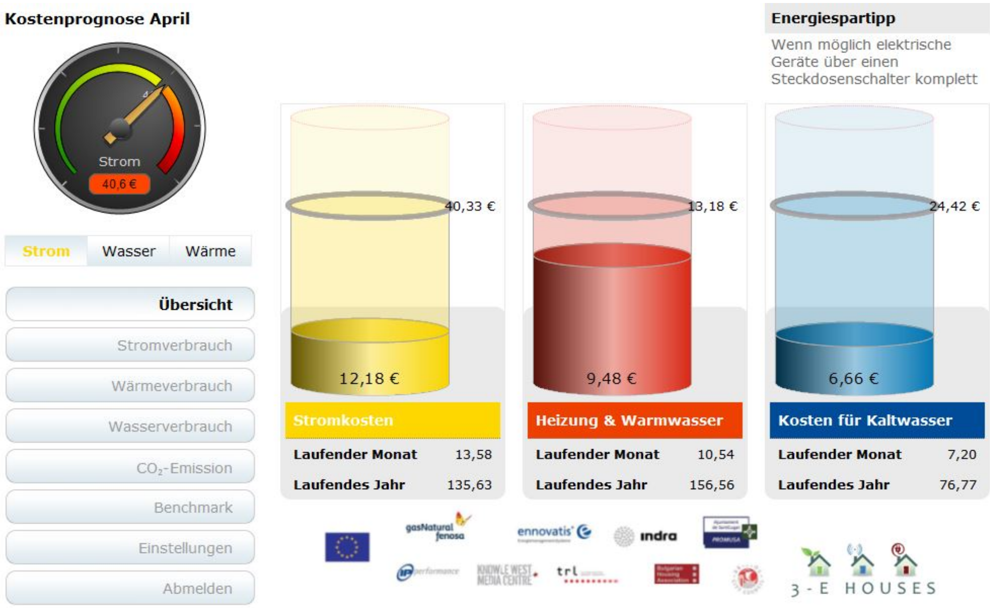

Figure 3. Overview page of the 3e-Houses web interface

In Figure 3the overview page of the 3e-Houses web interface is shown. It contains three “cylinders” which fill up each day, after the daily consumption data was updated. The prices in the cylinders mark the monthly fixed payment rate of the tenants, which helps to orientate on the current consumption. Below the cylinders the current monthly and yearly energy costs are shown. The user also can see on the main screen energy savings tips in the upper right corner of the screen. Furthermore en energy prognosis tachometer gives a prognosis for all three types of consumptions (water, electricity, heating). In the navigation list on the left site the user can access further information, options and log out.

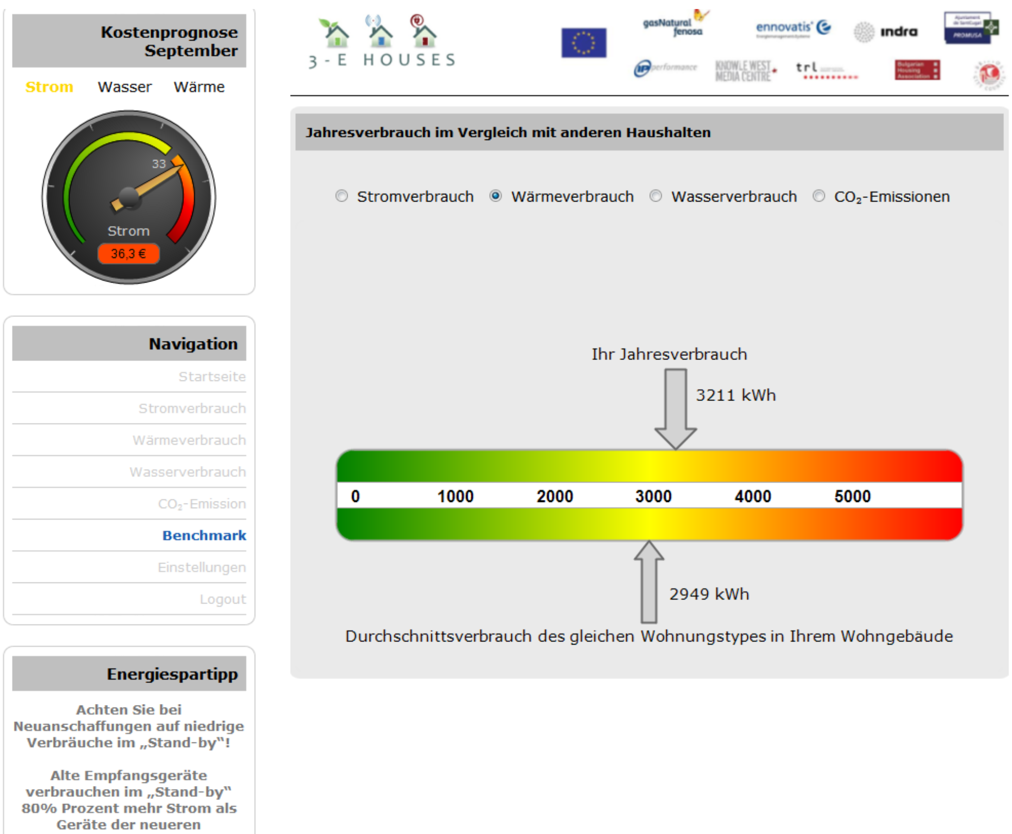

Figure 4. Benchmark page of the 3e-Houses web interface

Figure 4 shows the benchmark page of the 3e-Houses web interface. The user can compare the yearly energy consumption of his household with other households of the same type in the same building.

Figure 5. Detailed view of monthly heating consumption of the 3e-Houses web interface

In Figure 5 the user is able to see his detailed, monthly heating energy consumption as well as the consumption of the same month in the previous year. He can also change the detail to weekly consumption and can access the overview of the past and current energy cost of the current year.

Therefore, the idea for EEPOS is to take the work in the 3e-Houses project as a basis and develop the EEPOS web interface further on. The public report Dave Tuffery et al., D.4.1 – Guidelines and best practices for energy efficiency in social houses from June 2013 (http://www.3ehouses.eu/sites/default/files/3eHouses_D4-1_Guidelines_and_best_practices.v23.pdf) contains a summary of guidelines and recommendations which should be taken in to account for the development of the EEPOS end-user interface which are the following:

“Data visualisation software

It is important that the data visualisation software is widely compatible with today’s web technologies. For this reason, an HTML5 framework front-end is recommended to contain the interface. Flash animation software can be used to design the interface, although creating the animation in pure HTML5/JavaScript would provide for much greater future proofing. It is possible to use open source software for creating the front-end framework and drive the back-end of the software, with one particular advantage being the flexibility and creative freedom afforded to create original and engaging graphics that are visually fit for purpose.

Front-end interface design

It is important for tenants to have an easy means of viewing their own energy consumption. The degree of complexity has to be appropriate for the type of tenants in the buildings.

Generally, older generations and people less well educated and comfortable in the use of ICT will require a simpler interface that they are comfortable with. Conversely, those who are more comfortable with ICT and use the Internet regularly may wish to have more information available to them otherwise they will lose interest. "

Overall guidelines for the interface

As a result of the pilots and replicators, the following guidelines are recommended as the basis for the front-end interface design for its usability and effectiveness:

- It is recommended that energy use is displayed as actual cost as this is more understandable than kWh and has a higher motivational effect;
- Displaying an anonymous comparison with neighbours or a regional comparison allows the tenant to put their energy use behaviour into context;
- Additional design features, such as displaying project news updates or advice and tips on how to save energy, has proved popular in the pilots and replicators;
- Periodically developing additional features and functionality is also a good idea to keep people interested so long as it does not make the information too complex or difficult to understand;
- There is also the potential to use this technology as a method of social networking and community development;
- Displaying more than just total energy use will require adequate training, which can be delivered either in a group workshop or by individual training sessions. However, there is no guarantee that everyone will use the interface regularly and some regular encouragement or re-enforcement of the messages might be required.

The German pilot noted the importance of ensuring energy use data is correct, particularly when providing energy cost, because residents are able to compare the interface information with their energy bills. Any discrepancy could have result in a loss of confidence and decrease in engagement. However, a prognosis of the expected monthly energy cost was especially interesting for German tenants, who pay a monthly fixed rate for their energy consumption.

Recommended features

Based on the lessons learnt from the pilots and replicators and the feedback received from participants, it is believed that the following features are important to include on the web interface:

Overview page:

1. Real time 'live' energy consumption visualisation
2. Current monthly costs for heating, water and electricity energy consumption;
3. Graphical presentation of current monthly costs and distance from monthly fixed payment;
4. Calculated numbers of current monthly and yearly costs;
5. Prognosis of monthly energy consumption;
6. Presentation of personalized energy saving tips (taking into account the consumption profile of each tenant);

Detailed views via navigation list:

7. Weekly and monthly graphical data visualisation for water and heating consumption and CO_2 consumption, with monthly comparisons from the previous year's data;

8. Hourly, daily and monthly graphical data visualisation for electricity and gas consumption, with monthly comparisons from the previous year's data;
9. Benchmark views to compare the own energy consumption with average data of the same type of households (e.g. number of occupants, type of building, number of bedrooms);
10. Settings to allow user to set unit costs for heating, water, electricity and gas.

Innovative features to increase engagement

The Spanish pilot noted the importance of social benchmarks and incentives to increase the engagement. The German and Spanish pilot of 3e-Houses project introduced the idea of providing personalized energy saving tips to raise interest in the interface, with some success.

Initiatives such as the Spanish pilot Ecopoints program were found to be successful in encouraging the tenants to save energy and can be recommended. This was focused on achieving demand response from the tenants, shifting their consumptions from peak to off-peak hours, when the cost of the electricity was lower and the associated CO_2 emissions lower still.

The UK and German replicators tested the effectiveness of incorporating other information, with the use of web applications, into the interface with the aim of increasing its use. These web applications delivered services such as local football results, traffic and weather that would enhance the participants' involvement with their local community and hopefully increase engagement. However, feedback made it clear that this confused participants as it was unrelated to energy saving. Consequently, further web applications were selected to add more information about actual energy usage. It is recommended to keep the interface design related to energy matters.

Further considerations

Overall the UK interface worked well with participants enjoying using it. This is supported by the surprisingly high usage of the UK interface, and is even more surprising given that a number of high energy consumers did not save much energy. The interface graphics used in the UK replicator are unique and hence may not be appealing to everyone; Dane Watkins originally created them for an arts project (http://whosedata.net) run by Knowle West Media Centre, one with the aim of connecting people and open data. It appears on the face of it that this worked, with participants coming back for more; yet some participants who accessed the interface a lot failed to make significant energy savings.

This raises the question of whether any information was missing from the interface, and indicates the difficulty in matching the level and graphic design of the information to suit to a varying target audience. The socio-economic analysis presented in Deliverable 4.2 indicated that the interest in the interface declined more rapidly with the increasing level of education of the participant – with those holding Master's Degrees losing interest much faster than those with just GCSEs. It is arguable that some people are content with a simple graphical representation of their energy use, whilst others have an expectation of gaining a greater detail of understanding. Perhaps then, in the UK replicator, the simple, animated graphics could be improved by providing the ability to 'drill down' into deeper layers of the display to access more detailed information, making it available for those who want it but without cluttering the initial display for those that prefer a simpler interface.

Hardware device for accessing portal

It is especially advised to provide residents with a mobile device for viewing the web interface. No such device was provided In the German pilot, instead participants were expected to use their own PC or make use public Internet access, such as a local library or café. As a result, the German pilot interface activity was low. In contrast, the German replicator did provide a tablet PC to participants with the result that interface activity was much higher, arguably due to the ease of use and access provided by the mobile device.

In the Spanish pilot, the Toshiba tablet was initially used but some participants complained about the poor battery life because the tablet switched off suddenly. It was decided to retire all the Toshiba tablets from the pilot and replace them with another touch screen, Android-based tablet, the Archos7 Home Tablet – this is also a touch screen.

It was considered during early design discussions that the ideal way to display participants' energy consumption data would be a single purpose touch screen device that could be positioned in a commonly accessed place in their dwelling, such as on their fridge, and should always be on and viewable at a glance. Initial concerns were that a web portal on a computer requiring log-in authentication each time might create a potential barrier to its use. However, the cost of developing a stand-alone device solely for this purpose is considered impractical at this time, whereas the wide availability and relatively cheap cost of Android tablet PCs makes this a viable alternative. For example, the German replicator introduced an ODYS 7" tablet, whilst the UK replicator chose the Toshiba AT100 Android tablet. Some participants complained about the small size (7") of the Tablet PC, so it should be remembered that elderly or some people with disabilities may benefit from a larger display.

A further advantage of the Android operating system is that its standard web browser could be used to display the interface so that no complex bespoke engineering would be required. The disadvantage was that the tablet could be used for many other things, such as browsing other web pages or playing games, all of which would distract the participants from the device's primary intended use. It could also be left somewhere in the dwelling where it might not be available to be glanced at frequently.

It is recommended that there is robust testing of interface technology in laboratory and real life situations before distribution to housing tenants as the poor reliability has shown marked affect on the motivation and continued engagement of householders."

Where at in the 3e-Houses project the focus was on simple visualisation of measured consumption data and a prognosis of the consumption data for a specific period of time, the EEPOS approach is much more. In this project the end-user, as a prosumer, will need more information, which shall be provided by and end-user interface. For the German demonstrator EEPOS project it is essential to provide the end-user with the following information:

- Current price / tariff of the electrical energy to buy from the energy supplier
- Current electrical power output of the CHP
- Current price of electrical energy to buy from the CHP

- Current price to sell self produced electrical energy (currently no buildings with production available)
- Current price / tariff of heat energy to buy from the heating energy supplier
- Current price of the running of the heat pump (one building)
- Current heating power output of the CHP
- Current price of to buy from the CHP
- Current price of to buy from the CHP in combination with wood chip plant
- Current price of to buy from the CHP,wood chip plant in combination with gas heating unit
- Current price of to buy from the CHP,wood chip plant in combination with oil heating unit
- Current price to sell self produced heating energy (currently 1 building with geothermal heating energy production available)
- Prognosis of electrical and heating energy and water consumption
- Weather data
- Benchmark to compare consumption / production data with other tenants, or average values
- Room temperature and humidity (sensors are available in dwellings which participated in the 3e-Houses project
- Historical and current consumption data for electricity, heating and water consumption in different time periods (per minute, per 15 min, per hour, per day, per month, per year) – if meter provides specified reading cycle

4.2.2 Social networking possibilities

EEPOS will apply a human-centred design approach with a special focus on the human-in-the-loop in T3.4. The finding of appropriate feedback methods, contextual analysis, sketching and user evaluation are accompanied by iterative end-user involvement and results publishing processes. This includes focus groups and social networks. This task applies and extends this approach in practice and considers the user as the starting point for finding resource-effective energy management and decisions support methods for neighbourhoods.

The End-User Collaboration tool offers an interface between the ICT Platform and Social media. This allows users to publish their energy saving and to compare their performance with others. Possible social media networks include facebook, Linkedin and Google+.

These stakeholder-driven service-oriented information systems facilitate information sharing which may increase end-user motivation, "*personal drivers*" and augments understanding of energy issues.

At least the following data is available per household at the german demonstrator:

- Heating energy consumption
- Electricity energy consumption
- Water consumption
- Indoor temperature
- Indoor humidity

Additionally it would possible to present the following data:

- Shifted energy in kWh
- Saving resulting from shifting in €
- Outdoor temperature
- Outdoor humidity
- Primary energy source (if applicable)
- Personal Ranking in the neighbourhood

4.2.3 Games interface, engines, platform possibilities

During the study period two competitions could be conducted. This would raise the awareness and interest of users towards energy savings and would increase the impact of published material in social networks.

Best results relay on the user understanding and engagement. This might prove to be a challenge.

The EEPOS platform (based on the OGEMA) allows multiple end-user tools to interface the system. Applications may include:

- A responsible gaming interface can be connected to the OGEMA though Apps which may show consumption data in a User-friendly manner (for example a user friendly graphical representation of the neighbourhood consumption).
- An "Eco-points" system, or serious game, which is provided by the end-user collaboration tool shall be used as an incentive for the end-user to shift loads in valley times of energy prices. The more load which will be shifted by the end-user, the higher the number of eco points and the bigger the chance to win a prize.
- One of the worlds leading gaming engines UNITY (http:// http://unity3d.com) may be used to combine the consumption data (from meters), calculations (like energy usage per m2 or simulation results) and for instance the 3-D model of the building as well as the landscape model in one screen.
- Furthermore, browser oriented applications allows both mobile application (iOS and Android) and computer applications to access EEPOS data.

4.2.4 Others

Further systems or requirements are not currently foreseen for this demonstrator.

5. APPLICATION DOMAINS FOR COLLABORATION TOOL

5.1 Demonstration in Finland

5.1.1 The scenario of the tool usage

This Tool usage is practice for the scenarios presented in the chapter 3.1.

Below is the comprehensive list of the activities (possible usage) of the selected scenarios. The continuation of this task will finally show which all are viable trough the demonstration phase from all stakeholders point of view.

- The end-user might allow indoor temperature to drop from 22 to 20 centigrade during high market prices to reduce electricity costs and cut peak loads. The normal temperature conditions will recover automatically when power prices have come down to acceptable levels.
- The end-user can activate the ‘away’ mode, thus allowing indoor temperature to drop down to 16 degrees celsius until return time. The normal temperature is recovered within forecasted low market price/consumption hours.
- During hot season indoor temperature is allowed to rise until 28centigrade and chilled mode is used outside of peak hours only.
- Cut the consumption manually by switching off electrical equipment
- Enable to cut or delay the consumption automatically based on preset limits and rule-sets e.g. delay the operation of washing machine, sauna, turn off stand-by consumption, dimming of lights.
- Discharge the energy storages up to preset limits
- Boost power generation
- Produce power. Produced surplus power loads the balance card with power credit according to real-time (sell) tariff. In principle it does not matter how the power is generated – via solar panels, wind mills or diesel or gas engine-generator. In some cases, to stimulate renewable energy production more credit (better tariff) can be admitted for clean power production.
- Air handling units and ventilation system
- Heating and air conditioning system
- Electric car charge
- Outdoor lighting (dimming/switch-off)
- Lighting of common spaces (dimming, color adjustment, shorter delay of switch-off timer)
- De-icing applications

5.1.2 System diagram

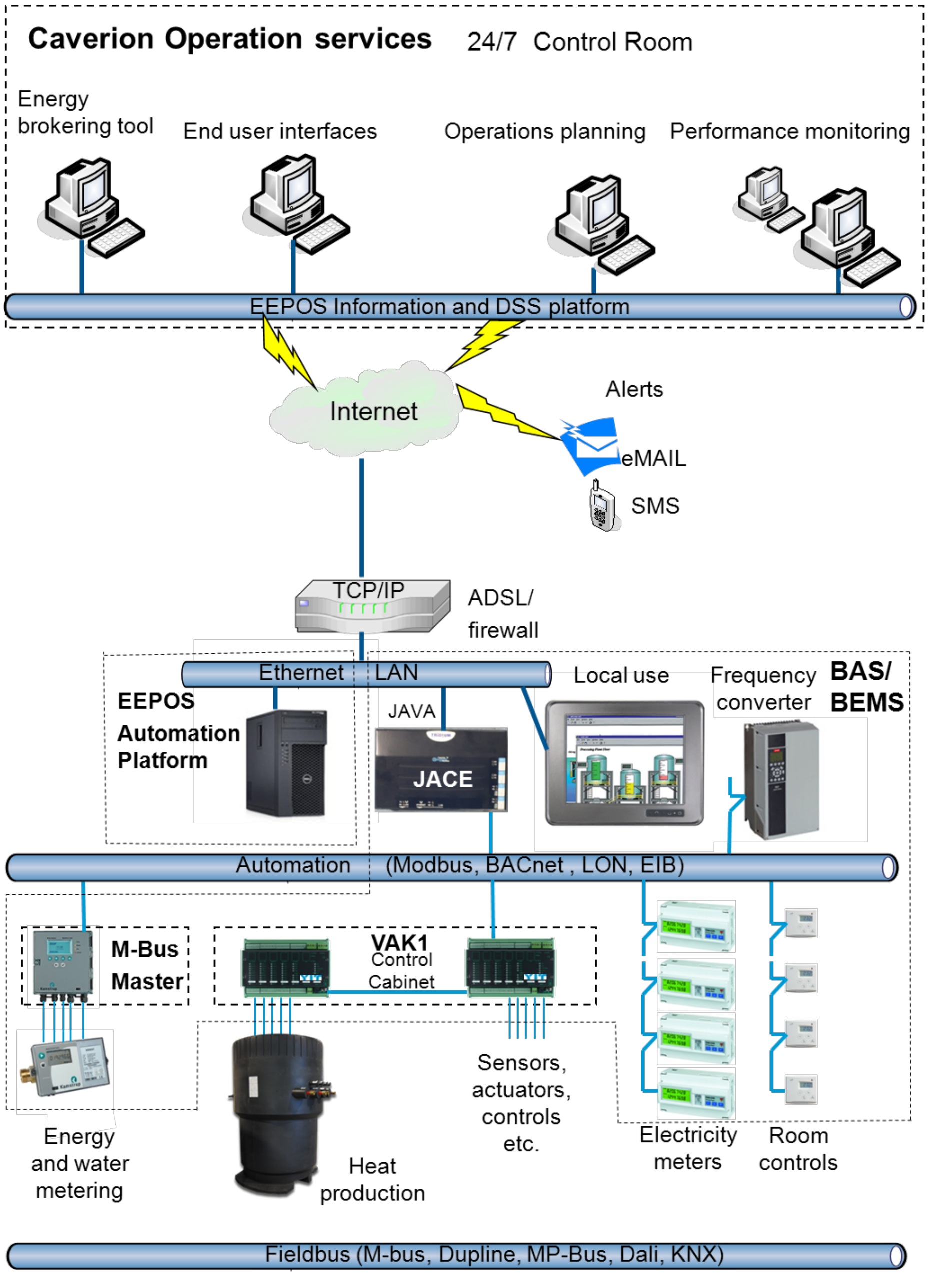

Figure 6. Caverion system diagram including EEPOS platform on top

5.1.3 Used technologies

End-user collaboration tool receives all necessary information through EEPOS automation and ICT platform.

Caverion NIAGARA is Tridium Niagara Framework environment utilizing web-based service software, which is designed for building automation and energy management needs.

Separate HVAC systems, acquired from property based **Caverion NIAGARA** software, can be integrated into a single web-browser manageable entity. Regardless of manufacturer-specific, closed systems, the **Caverion NIAGARA** opens the possibility for real-time monitoring of building technical systems via standard Internet browser.

Management and supervision of building technical systems is possible to divide among different specialist-organisations independently from the hardware location or integration level. Systems are managed by the same user interface using a standard LAN connected PC workstation without the need for user licenses.

Caverion NIAGARA is software scalable according to the service needs of customer. It can be utilised in large-scale commercial and office-buildings that have demanding processes requirements as well as in modest residential buildings, which can be formed into integral regional control systems.

Caverion NIAGARA is vendor independent on field bus level. Substation, control and field equipment is not restricted by one specific manufacturer or supplier. Best suited high quality equipment can be chosen according to the needs of specific site.

Communication protocols:

- Main meters (water, heat) to JACE: M-Bus
- Main electricity meters to JACE: Modbus-RTU (or M-Bus)
- Sub metering system to JACE: M-Bus
- Radio temperature and humidity sensors to gateway: 868,30 MHz
- Gateway (for sensors) to JACE: Modbus-RTU
- Heating regulation units to JACE: Modbus-RTU
- Operation panel for ventilation unit to JACE: Modbus-RTU
- JACE to BEMS server: TCP/IP
- BEMS server to NEMS server: TCP/IP
- JACE to operation services: TCP/IP

For gaming and visualisation 3D model is needed.

5.1.4 End-user Collaboration Tool

As described in earlier chapters UNITY (http:// http://unity3d.com) was discussed in the workshop. There is a foreseen and tested possibility to combine the data (from meters), calculations (like energy usage per m2) and for instance the 3-D model of the building as well as the landscape model in one screen easy to use for End-user

The tool (interface) will be developed to a browser (= PC) but will be also translated to an iOS And Android Application.

5.2 Demonstration in Germany

5.2.1 The Scenario of the tool usage

Four different energy consumption feedback scenarios were selected for a long-term comparison:

(1) annual energy bill,

(2) monthly billing information (monthly letter including cost and consumption overview)

(3) home display (providing real-time feedback, detailed daily and monthly statistics, weather information, a clock and energy saving advices, see Figure 1),

(4) web portal (accessible via PC and Smartphone, providing real-time feedback/monthly, daily statistics and energy saving advices, see Figure 2 to 4)

Scenario 1 may be used as control group, since users only get an annually report concerning their consumption. This allows an unbiased mode of operation.

In scenario 2 users are monthly informed about their consumption, allowing them to adapted their habits.

In scenario 3 and 4 users gets a live feedback concerning their consumption and mode of operation. In both these scenarios, Ennovatis Smartbox is used to access the historical monitoring data. It would be possible for the user to set a upper limit (alarm) for his own consumption.

5.2.2 System

In the German demonstrator the Smartbox is the "heart" of the building energy management system and will be used to obtain energy consumption data from the sub metering system (heating, electricity, water) and related comfort data (temperatures, humidity) of each individual dwelling and the building itself (7). Additionally, the Smartbox is also connected to the heating system of the building and hence it is able to use the obtained data also for visualisation purposes within the end-user collaboration tool. All of the data which will be logged and stored in the Smartbox can be used to present in the collaboration tool. If data is needed, which is in original not existing, from a meter or sensor (e.g. m³ from gas meter) it can be calculated with existing formula calculators in the Smartbox.

For the visualisation of meter data and sensor data, which is directly stored in the Smartbox there are technically two possible options:

Option 1: Transmission of logged data from the Smartbox to a central data server (SQL or energy management software) where the collaboration tool is running.

Pro:

- historic data of a longer period (since start of data logging) will be visible
- more options for data visualisation, by using a website with HTML frontend etc.
- data can be saved permanently

Contra:

- consumption data needs to be transmitted via Internet (limited data security)

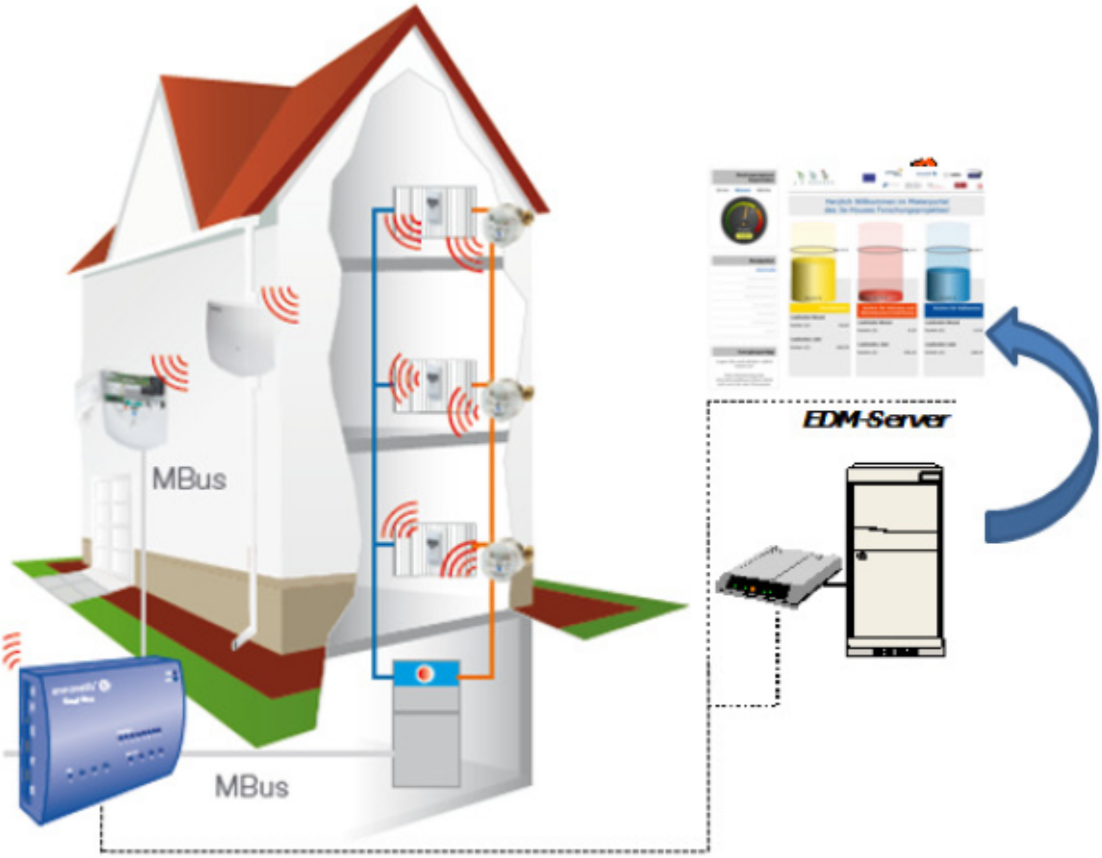

Figure 7. General functionality scheme of option 1 – Data logging with Smartbox and transmission to data server

Option 2: Logged data will be stored in the Smartbox only and directly used for visualisation.

Pro:

- consumption data doesn't need to be transmitted via Internet and remains "in the building"
- high data security
- Android app could be used for data visualisation

Contra:

- data can be stored only temporarily on memory card
- Android device is necessary for each user
- Limited possibilities for visualisation
- Data visualisation need to be separated from end user collaboration (further information from NEMS necessary)

Figure 8. General functionality scheme of option 2 – Data logging and visualisation with Smartbox

Resulting from both prescribed options the first **option 1 (figure 7)** will be used for the realization in the German demonstrator.

5.2.3 Used technologies

The Smartbox-OGEMA interface

To transport data from the Smartbox to OGEMA and back to the Smartbox, a small JAVA program will be used. The advantage of the Java programming language is, that it could run almost everywhere where a JVM[1] can run. Previous projects have shown, that this is a very reasonable solution. With the implemented code it is possible to contact several Smartboxes, read arbitrary data and put the data to arbitrary targets. For the EEPOS Project one new Target has to be implemented: the Interface to OGEMA.

[1] JVM: Java Virtual Machine

The general Information and data flow diagram looks like:

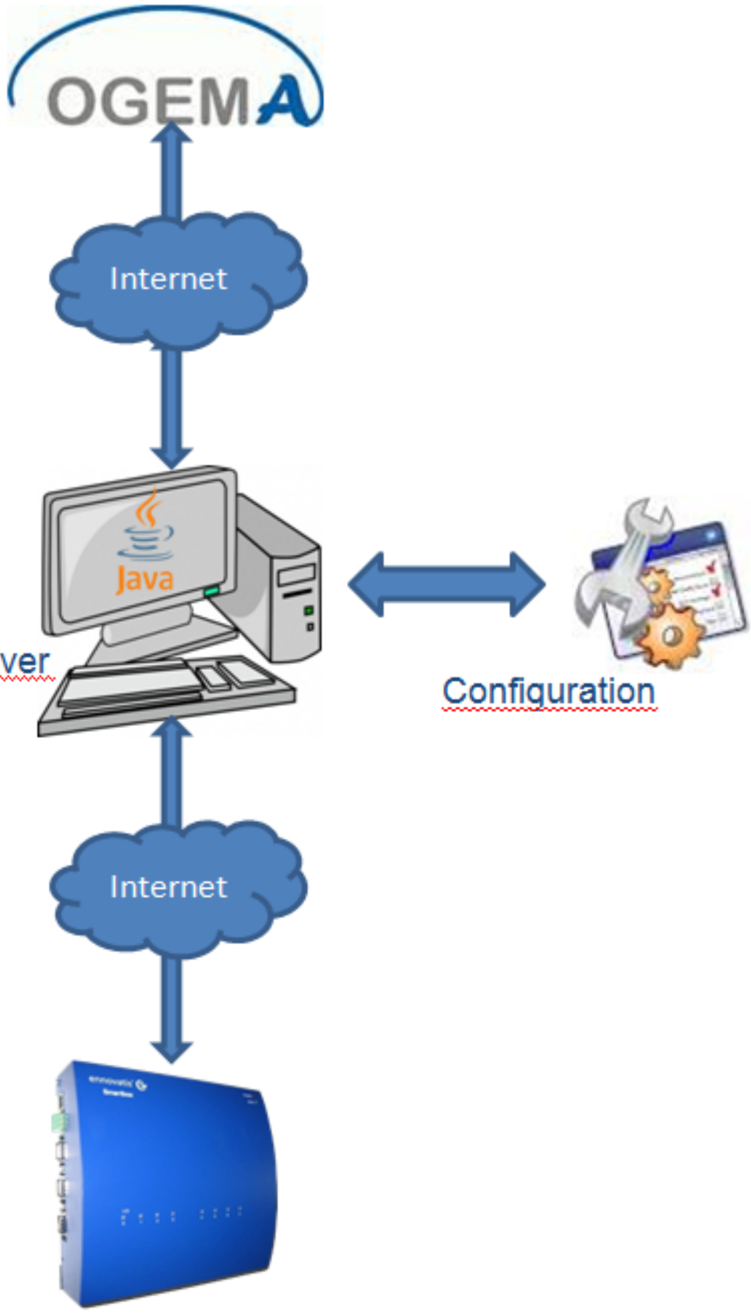

Figure 9. OGEMA-Smartbox Java interface

This assumes that all Smartboxes are accessible via network (TCP/IP). The Java driver could be running on any permanent running machine connected to the network. This could be on the OGEMA Server itself, or on a small machine nearby the Smartbox. For the later we already used the little "Raspberry PI" System. But of course – this machine could run at any place as long as there is a network connection! One big advantage of running the driver at the installation site is that the customer will get some piece of real hard- and software, which has to be installed – not any virtual service running on an opaque server side. Additionally the System is controllable by the customer, if it should run or not.

The java driver itself needs some configuration to do his work properly. For this, the driver could be set an installation mode. The driver will search for (local) Smartboxes and writes them together with the available data points in a new configuration file. This file has then to be edited and supplemented with additional information:

Since more than one Smartbox could be installed at one site, the configuration file could consist several entries. Each of which needs additional Information: User and Password for the login process. And each data point needs to be assigned a dedicated OGEMA Information point. Furthermore the network addresses and login data to the OGEMA System must be specified.

Once the configuration is complete, the driver could be started. The configuration is read in and the data points are exchanged with the OGEMA system.

For the announced optimization, the OGEMA system provides some information back which is read by the driver and put into dedicated (defined by the configuration) data points in the Smartbox. These Smartbox data points are set up as “could be” data points. This means, that these data points are only considered if they are set within a certain time period. Otherwise the default behaviour takes place.

With this “could be” data points, it is very easy for the customer to set up or shut down the system. One could think of a reserved feature which could be used just by running the interface driver.

One further advantage to use a local running OGEMA driver on a separate System is the minimum usage of different systems involved in the communication process. This in turn, leads to almost real-time data within the OGEMA system, to a minimum of maintaining costs of the whole system as well as the possibility to set up a final assembly of a user ready system.

5.2.4 End User Collaboration Tool

Feedback approaches will be selected with regard to a balanced mix of traditional printed approaches as well as ICT based approaches displaying real-time consumption data in different ways (ambient or detailed statistics).

Feedback approaches will be assigned to consumers by a layered sampling procedure, including demographics and data regarding living context (size of flat and size of the household).

The German demonstrator will use the transmission of logged data from the Smartbox to a central data server (SQL or energy management software) where the collaboration tool is running.

One of the world’s leading gaming engines UNITY (http:// http://unity3d.com) may be used to combine the consumption data (from meters), calculations (like energy usage per m2 or simulation results) and for instance the 3-D model of the building as well as the landscape model in one screen.

Furthermore, browser oriented applications allows both mobile application (iOS and Android) and computer applications to access EEPOS data.

6. CONCLUSIONS

6.1 Summary of achievements

The VTT was responsible for the compiling of general content and the (Finland/ Germany) demonstrator contributions was per country and are presented parallel in this report. The structure and content of the document is to fill both the overall structure of EEPOS as well as the demonstrators.

6.2 Relation to continued developments

This task of End-user collaboration tool is a direct continuation from contents in scenarios (D1.1), stakeholder requirements (D1.2),architecture (D1.3) and technical description (D3.1) being an essential part of combining knowledge to meet the EEPOS project targets.

This task also has a practical relation to the OGEMA platform developed further to EEPOS platform.

Relation to standards in the demonstrators is the work done to have various standard products e.g. SmartBox, Jace connected and in use using EEPOS platform.

Furthermore the End-user collaboration tool is going to have the interface based on gaming engine called Unity3D. The optimal vision for the final result is to use the same end user tool (The App) for 2 demonstrators based on the EEPOS platform as a "middle layer" but having individuat setups e.g metering using Jace vs Smartbox.

6.3 Other conclusions and lessons learned

The conclusion of this very short period of 6 months including summer holidays (M7..M12) has shown the usability of good planning as well as the diversity of the activities based on plans.

The anticipated lesson learn was the numerous variables in the previous tasks resulting the starting point to task 3.4 as well as the diversity of the demonstrators by nature.
However, the actions within this project are planned and will continue as dynamic as normal European level activities where there is no universal but good extended solution that fits for all.

Even well planned, the timing of the all tasks with parallel actions has been made this report challenging. The work by all partners has been good and based partly on the draft versions of previous reports. From this report on the task activities are better in line with other tasks activities because of the bigger amount of information available and more decisions made along the project.

7. ACRONYMS AND TERMS

ADSL………………	Asymmetric digital subscriber line (ADSL) is a type of digital subscriber line (DSL) technology, a data communications technology that enables faster data transmission over copper telephone lines than a conventional voiceband modem can provide.
Android……………	Operating System for Android Phones and Tablets
BAS ……………….	Building Automation System
BEMS……………..	Building Energy Managment System
BIM………………..	Building Information Model
EEPOS…………….	Energy management and decision support systems for Energy POSitive neighbourhoods
EMS……………….	Energy Management System
Ethernet……………	A family of computer networking technologies for local area networks (LANs)
GCSE………………	General Certificate of Secondary Education
HTML5……………	markup language used for structuring and presenting content for the World Wide Web and a core technology of the Internet.
HVAC………………	heating, ventilation, and air conditioning)
ICT…………………	Information and Communication Technology
IFC…………………	Industry Foundation Classes
iOS ………………..	Operating System of iPhone or iPad
JACE……………….	Java Application Control Engine
Java…………………	general-purpose, concurrent, class-based, object-oriented computer programming language that is specifically designed to have as few implementation dependencies as possible.
JavaScript…………	interpreted computer programming language
LAN……………….	Local Area Network
M-Bus……………..	a computer bus designed for communication between high speed system components
NEMS………………	Neighbourhood Energy Management System
OGEMA……………	Open Gateway Energy Management Alliance
RES………………..	Renewable Energy Sources
UNITY…………….	One of the most used game engines (http:// http://unity3d.com)

8. REFERENCES

[1] E3_Houses Project
(http://www.3ehouses.eu/sites/default/files/3eHouses_D4-1_Guidelines_and_best_practices.v23.pdf)