

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



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Deliverable 5.2

Baseline report on German Demonstration



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1. PUBLISHABLE EXECUTIVE SUMMARY

For the German demonstrator in the EEPOS project a neighbourhood, which consists of different types of buildings located in Langenfeld, Northrhine-Westphalia, was selected. Out of a number of about 120 buildings five buildings were included in the EEPOS project and ten family homes are participating as end-users in the project. All buildings, including the participating ones, are connected to a local district heating plant, which produces heat to heat the buildings with a renewable energy source of wood chips (RES) as well as heat for the domestic hot water production and electric energy with a combined heat and power plant (CHP). The German EEPOS demonstrator is mainly based on an existing energy management, which was installed by the project partner ENO for the housing cooperation Bauverein Langenfeld (BVL) and updated with smart meters and additional sensor technology in the EU project 3E-HOUSES. The five buildings, which are included in the EEPOS demonstrator are all of different years of construction. One of the buildings is considered to be a historical monument. The ennovatis energy management collects data of heat, water and electric energy consumption of each of the participating dwellings and is additionally connected to regulation unit of the heating substation and collects data of the heat meter in each building. Currently this data is being used for billing reasons and to visualize energy consumption data to each household in the neighbourhood.

The EEPOS project aims to use the existing energy management system and the obtained data to implement EEPOS scenarios, which themselves were defined in D1.1 and their integration in the demonstrator in D4.1. To include a number of end-users it was necessary to run a specific engagement campaign, which included the design and distribution of posters, flyers etc. and an information meeting to inform potential tenants about the objectives of the EEPOS project. The engagement campaign ended in May 2014 successfully, with a signed agreement of ten participants. After the engagement campaign the participants had to answer a survey and had to provide their energy consumption data. Some tenants showed already from the beginning concerns about the general approach to shift electric loads to other times of the day and mentioned problems with noise or named open insurance related questions. Knowing those results of the engagement campaign the project partner ennovatis started in parallel to WP4 laboratory tests to develop a reliable technological solution to implement the previously defined EEPOS scenarios.

During Task 5.2, a ZigBee technology to control household appliances with data input of the EEPOS Automation platform (OGEMA) in connection with the ennovatis Smartbox was developed, but could not be successfully tested. Hence, a data visualization display was chosen and adapted to the needs of the EEPOS project. Instead of automated control of household devices the end users of the German demonstrator will be able to use a LCD display, which provides forecast information of energy prices and weather. Additionally, a feedback button on the display will send data regarding the users availability at home. The existing communication structure was checked and reconfigured to meet the EEPOS demands and some additional meters and sensors were installed. A new energy management system was installed in the local district heating station and the energy production was calculated with the obtained data. Furthermore energy baseline data for electric energy consumption of the ten participating households and heat consumption baseline for the five buildings were calculated using the existing methodologies developed in previous CIP ICT-PSP projects. The results of the energy baseline calculations are included in this report. All the developments in Task 5.2 were made with the existing knowledge of previous projects, where the partners AIT and ENO were participating. A summary of lessons learnt from these projects is also included in this deliverable.

2. INTRODUCTION

2.1 Purpose and target group

The purpose of this document is to describe the starting points of the German demonstrator and to define energy baselines for further assessment. The report is the outcome of Task 5.2 under Work package 5 (WP5) in the EEPOS project. The report will provide all relevant information, which needs to be taken into account for those who want to implement a similar pilot to demonstrate energy management activities in energy efficient neighbourhoods. The report will include technical definitions of the solution which will be implemented in the demonstrator buildings and will prescribe existing frame conditions.

2.2 Contributions of partners

The report was written with contribution of the EEPOS partner AIT.

The exact partners' contributions are shown in the table below.

Section / Chapter	Contributor
1, 2, 3.1-3.5, 4, 5.1, 5.2.1, 6, 7, 8, 9	ENNOVATIS GMBH (ENO)
3.6, 5.2.2, 6	AIT Austrian Institute of Technology GmbH (AIT)

Table 1. Partners contributions

2.3 Baseline

Several CIP ICT-PSP projects of the FP-7 program like BECA, eSESH, E3SOHO, ICE-WISH and others as well as in previous funding research programs of the EU have already implemented similar demonstrators. Therefore a quite good knowledge and experience on how to implement a technical demonstrator already exists. Especially the EEPOS partners VTT, AIT and ENO were already participating in projects which also include demonstrator activities. One of the last projects, where ENO was the leader of the demonstrator work package was the CIP ICT-PSP project 3e-HOUSES and did so also in the FP-7 project smartCoDe. In the 3e-HOUSES project demonstrators for ICT systems for energy efficiency in residential houses in Spain and Germany as well as replicators in UK and Germany were implemented. One of the German 3e-HOUSES demonstrators in Langenfeld will also contribute to the EEPOS project as the basis technology will be also used here. ENO has contributed to the final report and guidelines for energy efficiency in social housing of the project 3e-HOUSES [1] as well as to other public reports which are related to the work in the demonstrators.

2.4 Relations to other activities

The input of Task 5.2 is mainly based on the works and results of the work packages 1, 2, 3 and 4, where the EEPOS specific tools and platforms will be developed and tested in prototypes. The Deliverable D4.1 – “Integrated systems ready for demonstration” is a very important input, because it describes all the relevant technical aspects to implement the developed technology in real world scenarios, like the German demonstrator. Furthermore the

Deliverable D1.1 – “Validation strategy and application scenarios – revised version” includes the following important information:

- Which number of scenarios will be put when into practice and evaluated at which demonstration site
- How the status of the demonstration sites is defined
- How potential problems arising from the small number of energy sources at demonstration sites, the weak integration of renewable energy sources at demonstration sites and the lack of price fluctuation for end users will be tackled or circumvented.
- What is planned to balance the fact that end-users have no possibilities to change the energy supplier.

On the other hand the results of this report will be used as a basis for the final report of the German demonstration task 5.3 in the Deliverable D5.3 – “Results of German demonstration”.

3. PRE-CONDITIONS OF THE DEMONSTRATOR

3.1 Location and scope

The German demonstrator, in which the scenarios, described in D1.1, shall be validated, will be implemented in Langenfeld (Rheinland). The whole EEPOS demonstrator consists of six different buildings, where ten households are participating. The demonstrator buildings are part of a neighbourhood area with approximately 120 buildings. In all of the buildings a basic energy management system was installed by ennovatis in the years 2008/2009, which was upgraded with additional sensors and meters in the individual dwellings during the participation in the 3e-HOUSES project from 2011-2013.

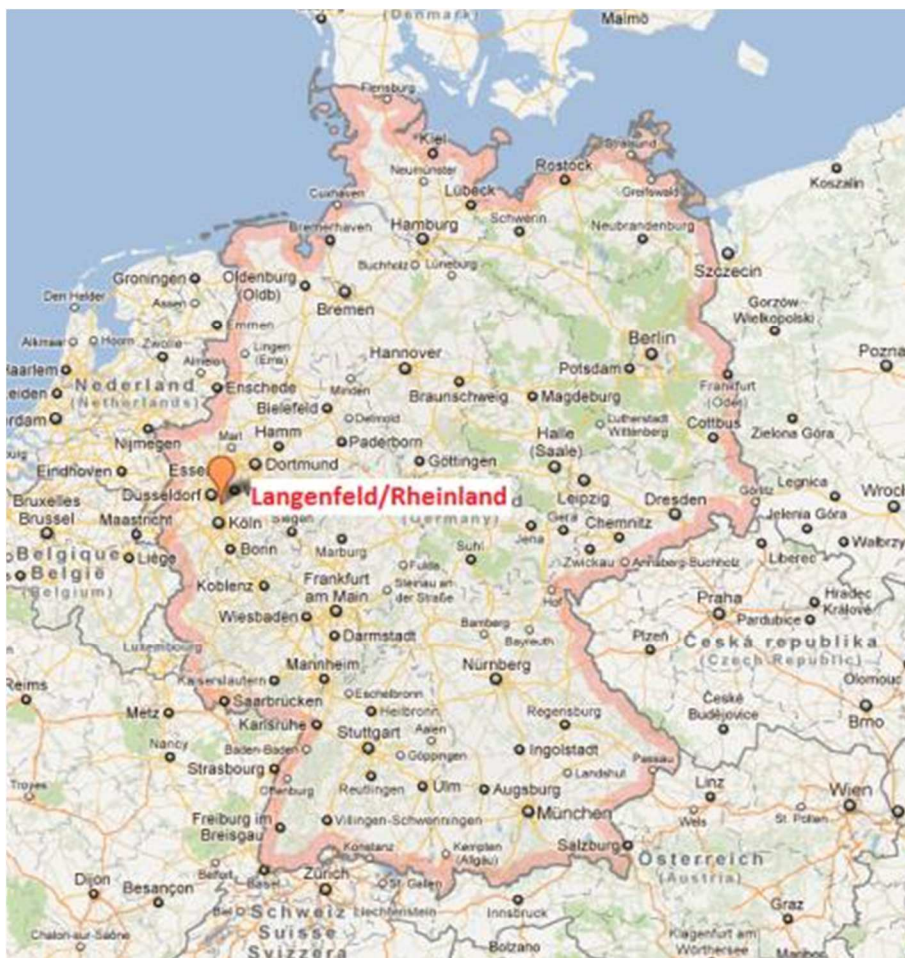


Figure 1. Location of the German Replicator site

3.2 Building particularities

Each of the buildings which are part of the German demonstrator are equipped with a heating sub station connected to the district heating system, which was installed in late 2012 and which provides heating energy generated by a wood chip plant. Furthermore a sub metering system has already been installed and measures the consumption of each dwelling with a separate heat meter or by heat cost allocators and cold water consumption in the flats on

average once a day. The data is being sent by radio to different gateways in the house and transmitted by the ennovatis Smartbox via M-Bus to collect the data of the water and heating consumption of the dwellings. The existing main heat meter of the building is equipped with an M-Bus module connected with the Smartbox. An additional water meter is also installed to collect the data via M-Bus. The hot water is being produced locally in the dwellings by separate electric flow heaters. The flow heaters are not separately measured with specific meters. The existing electrical meters are partly digital and partly analogue meters and measure the electrical consumption of every dwelling. Nevertheless the meters don't have an interface which allows reading out the data directly from the existing meters. To measure the electrical energy consumption of each participating dwelling sub meters with M-Bus interface were installed and connected to the Smartbox.

3.2.1 Martinplatz 1-3

The building is a residential building, in the centre of Langenfeld (Figure 2), specially equipped for tenants with elderly needs with 2 houses and 30 dwellings. Further details of the building are shown in Table 2. Three participating dwellings are located in Martinplatz 1. Two apartments have a size of 79,93 m² and have three rooms a kitchen and a bathroom and one apartment of 55,45 m² has two rooms and a bathroom. Further two apartments with the size of 79,93 m² (three room), and about 55 m² (two room) are participating in Martinplatz 3.

	Martinplatz 1 & 3
Year of Construction	2005
Number of dwellings	30
size of the building [m ²]	1802,48
wall isolation	brick with glass wool
types of windows	double glazing
DHW production	gas boilers in dwellings
heating technology	local district heating (wood chip)
existing billing technology(e-metering)	heat meters, water meters (since Jan. 2009)
	central heat consumption (15 min since Nov. 2012)

Table 2. Building specification Martinplatz 1-3



Figure 2. Martinplatz 1-3

3.2.2 Martinplatz 10-14

The building is a residential building, with three entrances, located in the centre of Langenfeld (Figure 3). Further details of the building are shown in Table 3. One participating dwelling is located in Martinplatz 14. The apartment has a size of 60 m² and has 3 rooms room a kitchen and a bathroom.

	Martinplatz 10-14
Year of Construction	1951
Number of dwellings	20
Size of the building [m ²]	1227
Wall isolation	no
Types of windows	Double glazing
DHW production	Gas boilers in dwellings
Heating technology	Local district heating (wood chip)
existing billing technology(e-metering)	Heat cost allocators, water meters (since Jan. 2009)
	Central heat consumption (15min since Feb. 2008)

Table 3. Building specification Martinplatz 10-14



Figure 3. Martinplatz 10-14

3.2.3 Paulstraße 4-6

The building is one residential building, in the centre of Langenfeld (Figure 4). It has five houses and 41 dwellings. Further details of the building are shown in the Table 4. One dwelling in Paulstr. 4 with 77 m² is participating in the project.

	Martinstr. 25/27/29, Paulstr. 4/6
Year of Construction	1994
Number of dwellings	41
Size of the building [m ²]	3125,6
Wall isolation	Brick with glass wool
Types of windows	Double glazing
DHW production	Gas boilers in dwellings
Heating technology	Local district heating (wood chip)
Existing billing technology(e-metering)	Heat cost allocators, water meters (since Jan. 2009)
	Central heat consumption (15min since Feb. 2008)

Table 4. Building specification Martinstraße 25-29 and Paulstraße 4-6



Figure 4. Martinstraße 25-29/Paulstraße 4-6

3.2.4 Martinstraße 40

The building is a residential building, in the centre of Langenfeld (Figure 5). Further details of the building are shown in Table 5. Both participating dwellings in the building have a size of 80 m² and are located in different floors, which are the 4th and 7th floor. The apartments are three-room apartments with a kitchen and a bathroom and a balcony.

	Martinstraße 40
Year of Construction	1979 in 2008 renovated
Number of dwellings	21
Size of the building [m ²]	1682,1 m ²
Wall isolation	Brick with glass wool
Types of windows	Double glazing
DHW production	Gas boilers in dwellings
Heating technology	Local district heating (wood chip)
Existing billing technology(e-metering)	Heat meters, water meters (since Jan. 2009)
	Central heat consumption (360 min.)

Table 5. Building specification Martinstraße 40



Figure 5. Martinstraße 40

3.2.5 Martinstraße 58

The building is a residential building, in the centre of Langenfeld (Figure 6) and has two houses each with six dwellings. Further details of the building are shown in Table 6. One participating dwelling is located in Martinstrasse 58. The apartment has a size of 45m² and has two rooms a kitchen and a bathroom.

	Martinstraße 58
Year of Construction	1952
Number of dwellings	6
Size of the building [m ²]	322 m ²
Wall isolation	No isolation (historic monument)
Types of windows	Double glazing
DHW production	Gas boilers in dwellings
Heating technology	Local district heating (wood chip)
Existing billing technology(e-metering)	Heat cost allocators, water meters (since Jan. 2009)
	Central heat consumption (360 min.)

Table 6. Building specification Martinstraße 58



Figure 6. Martinstraße 56-58

3.3 Results of engagement campaign

The project partner ENO had engaged a number of tenants in the project 3E-HOUSES to participate in a pilot in this project. After the end of this project the same participants were informed about the main objectives of the EEPOS project and were asked to participate in this project as well. For the general information an information brochure (Figure 7, Figure 8) was developed and delivered to each of the households as well as to other households in the neighbourhood. Finally, eleven households agreed to participate as test households in the EEPOS project. The participants had to sign a participation form, which allows to obtain energy consumption data and to analyse the data for project purposes.



Was benötigen Sie?

- Interesse an neuen Technologien
- Etwas Verständnis, falls mal etwas nicht nach Plan klappt
 - Standard-Haushaltsgeräte, wie Kühlschrank, Waschmaschine, Wasserkocher etc.

Wie kann ich teilnehmen?

Für die Teilnahme am EEPOS Projekt benötigen wir von Ihnen die Zustimmung zur anonymen Verarbeitung Ihrer Energieverbrauchsdaten sowie Ihrer Energieabrechnungen. Das dafür bereitgestellte Formular bitten wir Sie zu unterschreiben und in der Geschäftsstelle des BVL abzugeben.

Haben Sie noch Fragen?



Energieeffizienz
im **smart grid**



Das Projekt richtet sich an die Bewohner von Wohngebieten/Stadtvierteln, die durch die Entwicklung eines integrierten Systems für urbanes Energiemanagement Energie einsparen möchten. Insgesamt geht es neben der Verringerung im Energieverbrauch damit um weniger CO₂-Emissionen und um einen Beitrag zur Öffnung des Marktes für auf Informations- und Kommunikationstechnologien (ICT) basierende lokale Energiedienstleistungsunternehmen. Geplant ist:

- die Entwicklung von Zukunftsszenarien von neuen Geschäftsmodellen
- die Weiterentwicklung von Energiemanagementsystemen
- Entwicklung und Test von Informations- und Entscheidungshilfesystemen
- Integration von Pilothaushalten



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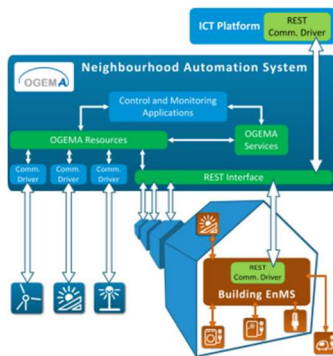


Figure 7. Information brochure - front page

Die EEPOS Projektpartner rufen Sie zur Mitarbeit auf!

NUTZEN SIE DIE CHANCE ZUR AKTIVEN MITGESTALTUNG DER ENERGIEWENDE

In EEPOS haben sich eine Reihe namhafter Forschungsinstitute und Unternehmen aus der Energiebranche zusammengeschlossen, um gemeinsam mit Ihnen an diesem Zukunftsthema zu arbeiten.



IHRE VORTEILE

Wir möchten Ihnen verschiedene Stromtarife anbieten und zahlen Ihnen die durch Lastverlagerung erzielten Einsparungen aus! Sie können dadurch ca. 150 EUR pro Jahr Stromkosten einsparen!



MIETERPORTAL

Die Erfahrungen aus dem 3e-Houses Projekt fließen in ein neues Mieterportal ein, welches von unseren finnischen Partnern erstellt wird.



TECHNIK UPGRADE

Falls Sie noch keinen fernauslesbaren Stromzähler besitzen, werden wir diesen für Sie kostenfrei installieren.



Meine liebe Oma, kannst Du mir mal bitte erklären, wie das mit dem Energiesparen funktioniert?

EEPOS – Energy management and decision support systems for Energy POSitive neighbourhoods

Figure 8. Information brochure – back page

Building ID	Dwelling ID	Street in Langenfeld	Floor	No. of rooms	Floor area [m ²]
MP1-3	1	Martinplatz 1	Top floor	3	79,93
	2	Martinplatz 1	Ground floor	3	79,93
	3	Martinplatz 1	Top floor	2	55,45
	4	Martinplatz 3	Top floor	3	79,93
	5	Martinplatz 3	Top floor	2	55,45
MP14	6	Martinplatz 14	1st floor	3	60
P4	7	Paulstraße 4	Ground floor	3	77,49
MS56-58	8	Martinstraße 58	Top floor	2	45
MS40	9	Martinstraße 40	7th floor	3	80,1
	10	Martinstraße 40	4th floor	3	80,1

Table 7. Characteristics of participating dwellings

3.4 Results from first survey

A first survey was delivered to the participants of the German demonstrator right after the engagement campaign was finished in month 17. The survey included the following questions:

- Name and address of the participant
- Number of rooms and location of the flat in the building
- Current number of people living in the flat
- Historical consumption data of the last 3 years for electricity, water, gas and heat and number of people in the specified year
- Questions to the possible cooperation in the project regarding load shifting issues, like willingness to switch on the washing machine at different times as usual, manually or automatically
- Questions about reasons why load shifting could not be possible
- Configuration of the dwelling with appliances. Which are available and are they ready for load shifting?
- Number and technical data of appliances like boilers, flow heaters, washing machine, dishwasher, dryer etc.
- Questions of the general use of the appliances (which washing programmes are used, which temperatures etc.)
- Question, whether the participant would agree to exchange the existing appliance with a smartgrid-ready one.

The survey was created in a writable pdf document and sent out to the participants by email.

Results:

All participants of the German demonstrator answered the survey. The information given regarding the number of persons living in the household and the historic energy consumption are included in the analysis of the data in chapter 5.2. The results of the most important questions are summarized in the following table.

	A	B	C	D	E	F
Dwelling-ID	Willingness to shift energy loads of household appliances manually, after advices (from EEPOS tools)	Trust in the technology and permission to automatic control of household appliances by the EEPOS system	If A or B "NO", why?	Other remarks	Existing appliances suitable for load shifting	Appliance with existing time shifting function
1	Yes	Yes	-	-	Washing machine, dish washer, dryer	Dish washer
2	Yes	Yes	-	-	Washing machine, dish washer, dryer	none
3	No	No	I don't want to keep the appliances running when I'm sleeping or not at home.	Its probably not much appreciated by the neighbours to use the washine mashine during night.	Washing machine, dish washer, dryer	none
4	Yes	Yes	-	-	Washing machine, dish washer	None
5	Maybe	Maybe	Yes, if I can save energy costs	Need more information first.	Washing machine	none
6	Yes	Yes	-	-	Washing machine, dish washer	Washing machine
7	Yes	No	Data Security reasons. Doesn't trust a secure connection from EEPOS system to appliance.	-	Washing machine, dish washer, dryer	none
8	Yes	Yes	-	-	Dish washer	none
9	Yes	Yes	-	-	Washing machine,	Washing machine

					dish washer	
10	No	No	Is not sure, whether the insurance covers any damages caused during operation of appliances in absence or at night.		Washing machine, dish washer, dryer	washing machine, dish washer, dryer

Table 8. Summary of survey results

The other answers to the mentioned questions above, will be used as input in the hardware implementation activities in WP5.

As we can see not all participants are willing to participate actively in the EEPOS demonstration phase. Some of them (No. 7) have concerns about data security issues to transmit sensible data via internet. Some others (No. 3,10) are not willing to participate actively due to practical reasons (not to disturb the neighbours) or are not sure, whether they lose insurance coverage in case of a leakage of the washing mashine in the time of absence.

Nevertheless, most of the ten participants are willing to reduce their energy bills by shifting loads. Some of them might be able to use existing time shift functions on their household appliances, others are open to try the EEPOS tools during the pilot phase in the EEPOS demonstrator.

3.5 Implementation of the results of the laboratory tests

One of the main purposes of the Task 4.1 – Integrated system prototypes for demonstrators in WP 4 was to analyze the possibilities to control existing household appliances (e.g. washing machines) with the available energy management system ennovatis Smartbox. This work continued also in the beginning of WP5. For this reason the project partner ennovatis worked together with a local dealer of household appliances (HSG-Shop in Leipzig). The HSG Shop provided a number of control panels of different washing machines. The technicians at ennovatis analyzed the existing protocols, which were not compatible with the ones which the Smartbox already provided. One of the obstacles was, that an external control of an existing (older) household appliance will need to be opened, because the control panel of the device provides all the necessary interfaces, which need to be connected to the Smartbox. By doing this the warranty of the existing appliance will be not valid any more. At the end ennovatis couldn't find a reliable solution to control existing household appliances with the ennovatis by using the information which the OGEMA system provides. Therefore the decision was made to use an external LCD TFT display and visualize information to the end user. So, the end user will be able to receive a 24hour forecast information about the hourly energy price in addition with information about the weather of the following day. Furthermore the tenant might provide information about his availability for the next day. The following points summarize in short the problems and obstacles to connect existing household devices to energy management systems for automatic control:

- Existing appliances do use proprietary protocols or just simple on/off switches which need to be connected directly, by opening the appliance
- If a household appliance need to be opened for connection purposes it will lose any existing warranty. End users will not support this attempt.
- Point 1 and 2 apply also on new appliances which are being sold right now. Even “smart grid ready” devices provide only protocols which might communicate with device from the same brand (like e.g. Miele). The connection of other external devices is not possible.
- If a connection can be established to direct controller of a household appliance an “Start” button need to be pushed anyway by the end user, This can be only avoided, if the appliance provides a timer function to start in a certain time.
- The main problem by controlling household appliances, especially washing machines and dish washers is the fact that an absence of the user might cause into serious problems in case of damage (e.g. a water leakage). The same applies during night time. Tenants are aware of this problem and hence the willingness and trust to an automated control of such appliances is rather low. Tenants want to keep the control on what is going on in their house.
- Another obstacle for an automated control of especially washing machines is, that existing housing rules prohibit their usage during the nighttime (22:00-6:00) Hence, there is limited time to shift load in the household to this time.

Resulting of the points a GUI was developed to provide tenants information about a 24h forecast of the expected energy price and current energy consumption of a connected household appliance. The following Figure 9 shows the design of the GUI for the LCD home display. The following Figure 9 shows the design of the GUI for the LCD home display. The display was also included in the cover of the existing Smartbox (Figure 10), which offers ennovatis now also now the opportunity to sell the Smartbox with an integrated display to existing or new customers.

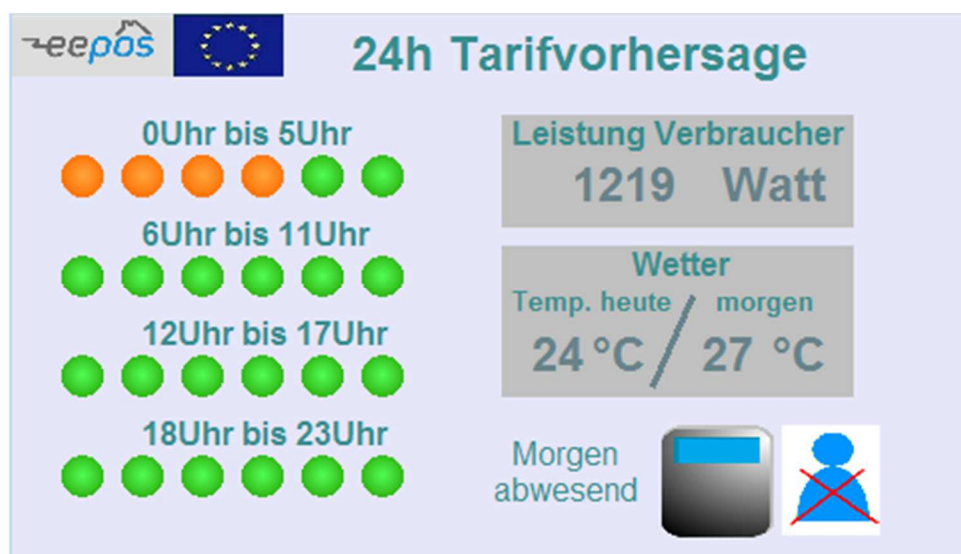


Figure 9. GUI of LCD display in tenant's homes



Figure 10. LCD display attached and connected to Smartbox

For the developments of the Unity 3D game engine, the project partner VTT received architectural drawings in dxf format of one of the demonstrator buildings (Martinplatz 1-3) in order to develop a 3D environment for the German demonstrator. With data from the German energy management system Smartbox the unity 3D will be used to visualize energy

3.6 Inclusion of lessons-learnt from other projects

Earlier projects also included demonstrators, where blocks of buildings (either neighborhoods or buildings that were spatially distributed) were used for various energy management tasks. Commonly these included a mix of automated solutions, where electric loads could be influenced without interfering with user comfort, and solutions where building users (tenants or people working in office environments) were actively involved, either by survey or by suggestions on how to change behaviour.

Within the national project Building To Grid (runtime July 2010 until March 2013) the load shifting potential of residential buildings was assessed and tested within a demonstrator of 10 buildings. The results showed that there is a low technological barrier to exploit load shifting potential in direct electric heating and electric night storage ovens, which are widely found in existing building stock. The challenges are in the correct estimation of available load shifting potential (i. e. electric power and duration), since this requires knowledge on installed heating capacity and the building physics that are responsible for the dynamics of the cooling process. Also the individual differences in tenant behaviour resulted in a wide variety of temperature setpoints and willingness to participate in load shifting programmes. Building To Grid also examined combined heat and power plants (CHP), which yielded a low DSM potential, mainly because CHPs are commonly designed to run permanently in order to get the maximum possible operation hours. This is due to economic reasons and resulted in a very small degree of freedom to change operation of the CHPs.

The system for predicting load shifting potentials was based on simplified thermal simulations of energy systems and building physics. While the system was able to make predictions on the

available load shifting time, it was challenging to define a simulation framework that is generic enough to cover all heating and cooling systems with their different abilities to provide load shifting potential. The prediction quality can further be increased by regarding local inputs, especially current and predicted outside temperature and solar radiation

With regard to communication, OpenADR proved as a viable protocol to exchange information about load shifting between buildings and central DSM coordinator. OpenADR is has a good development community and is today still actively promoted, so that it has the potential of becoming an established standard.

The project Consumer to Grid (runtime July 2010 until December 2012) lead a field test examining feedback methods for users to enforce energy efficiency measure. It used different feedback mechanisms: the more complex ones were an in-home display showing a mix of energy information and other local information like weather or public transport schedules and a device for giving instant feedback of the current electricity consumption. Aside of that also simpler approaches were tested: providing an electricity bill on a monthly base (instead of five times per year) and access to a web portal giving detailed information about electricity consumption. The goal of the project was to assess the long-term impact of the different measures.

The project showed that technological solutions have an intrinsic high complexity that needs to be mastered in order to be successful. The inhome displays were well received, but were only considered to be trustworthy information sources, if they continuously provide relevant information. In case of communication failures, hardware failures or irrelevant data, the tenant tended to bring less attention to this measure. Therefore the efforts for robust hardware, easy installation and continuous maintenance should not be underestimated.

The field test itself required significant effort for the research partners, since a considerable amount of individuals needs to be addressed. In order to make statistically sound statements about the impact of a measure, a test group should have about 30 individuals that are active over the whole runtime of the field test. Given the natural fluctuations of tenants, the change in live situations and other factors it is challenging to maintain such a big group of interested individuals. It proved very helpful to have local partners that continuously were seeking contact with the test groups and established relations and trust on a personal basis.

When providing feedback about energy consumption, the real-time factor is important. Once a tenant explores the possibilities to change energy consumption, the system has to provide instant feedback. Delays of a few minutes are already decreasing the level of interest, systems that deliver data from the day before are considered uninteresting. Priority should be given to fast responses of relative changes rather than slow feedback of absolute (and exact) values.

On the legal side the privacy issue has to be clarified in advance and communicated to the participants so that they gain trust in the project.

In terms of operation of the field test a work flow definition is helpful, defining which role has which responsibilities. All components should be monitored regularly, in order to detect failures (e.g. of monitoring equipment or communication infrastructure). Analysis should be done also during the field test in order to detect possible needs for adaptations in setup or data collection.

A general issue that has also been shown in other field tests with user feedback methods is that awareness naturally decreases over time. As soon as first learnings have been made by to tenants the system does not represent a source of new information. This common phenomenon can only be addressed by continuously introducing new incentives to create awareness e. g. by providing new information over different communication channels (newsletter, direct personal contact, mail or others).

Furthermore, as was shown in the EcoGridEU project, where the aim was to include about 2000 households into a price driven demand response architecture on the island of Bornholm an unreliable feedback mechanism (whether this unreliability is actual or only perceived does not matter) will lead to tenants dropping out of the project either officially or de facto by not actively participating anymore. Design and reliability is therefore paramount to user integration.

The design aspect also holds with respect to the hardware involved. Bulky dimension or a piece of hardware looking unfinished or experimental, which has to be installed in a place where it is full view during every day behaviour by the tenant can lead to the tenant dropping out of the project again. It is also important to notice that a more finished look is a deterrent to the tenant trying to manipulate the hardware installed, as for example in the Consumer to Grid project, tenants obviously tried to repurpose a visible USB wireless 4G modem for their own use, or going as far to use the memory of a device for their holiday pictures.

4. TECHNICAL ASPECTS

4.1 Architecture of ICT systems

4.1.1 Concept of hardware systems in buildings

The existing building energy management system (BEMS) is based mainly on the ennovatis Smartbox, which collects consumption data of the main energy consumer e.g. heating but also collects data from the central heating regulation unit. The data which is obtained from energy meters and sensors is stored in the Smartbox. The stored data will be transmitted via TCP/IP connection to the energy data management server (EDM server) which is located at the Ennovatis head office in Großpösna, Germany. The software ennovatis Controlling can be used for data management, assessment and further processing. The following Figure 11 and Figure 12 show the concept of the communication structure.

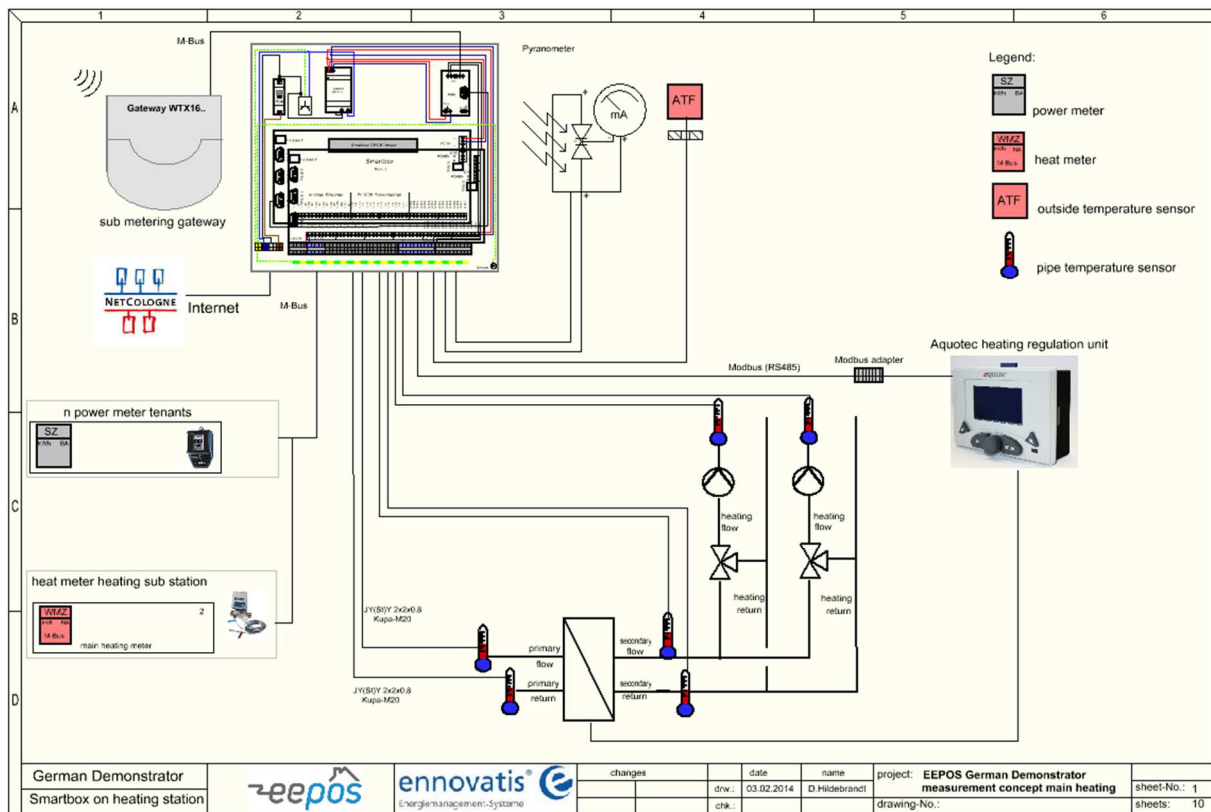


Figure 11. Energy management system installation on the central main heating

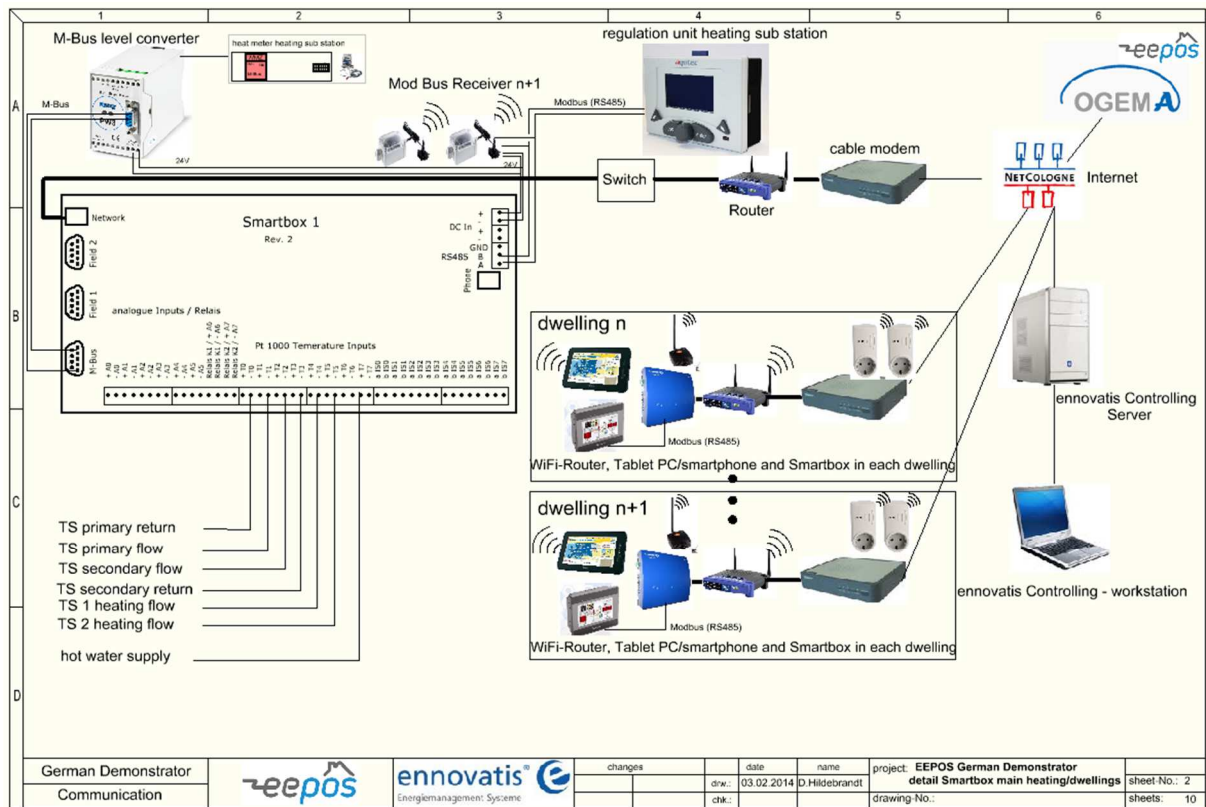


Figure 12. Connection of dwelling installations and EM system on central energy heating system

Communication protocols:

Main meters (heat, gas) to Smartbox: Impulse

Electricity meters to Smartbox: M-Bus

Submetering meters (EHCA, water) to gateway: radio 868 MHz

Submetering system to Smartbox: M-Bus

Radio temperature and humidity sensors to gateway: EnOcean 868 MHz

Gateway (for temperatures and humidity) to Smartbox: ModBUS-RTU

Smartbox to EDM server: TCP/IP

The components of the technical architecture of the German demonstrator global solution are described in the summary tables as follows:

- o **Data logger**

The ennovatis Smartbox collects all energy data of a building and transmits it for further processing.

It enables a completely new, high-efficient energy management of buildings. All data concerning energy consumption of buildings are collected fully automatic and round-the-clock and transmitted for further detailed processing. The ennovatis Smartbox is supplied in a

control cabinet which fulfils the IP 65 standard. A lockable control cabinet is available as an option, but not with IP 65 protection. The ennovatis Smartbox consists of a single PCB system, a power pack, a circuit breaker and various attachable components. In addition to this, options (e.g. M-Bus) can be secured to the integrated mounting rails or inserted into available slots on the PCB (e.g. socket modules or memory expansions). The housing is furnished with Pg connectors at the bottom (1 ea. M25, 4 ea. M16).

Not suitable for explosive or corrosive atmospheres. Conductive contamination, loose small parts and moisture may not be allowed to penetrate the control cabinet.

Storage:

5 to 50° C, no condensation, dry, frost-free, dust-free

Power Pack:

The ennovatis Smartbox is supplied with electrical power from the integrated, primary switched-mode power supply, which complies with the following performance data:

Input: 100 to 240V~, 50/60 Hz

Output: 24 V=

An optional 24 V= power pack can be integrated into the Ennovatis Smartbox IP 65 for simultaneously supplying multiple external sensors, for example, with electrical power.

LED Display:

Various LED displays are included on the PCB. The DIAG and COM displays can be found here

[see figure 6, item , and refer to the section entitled “Diagnosis / Status Display LEDs”].

DIAG LED: Blinks green (status: OK)

COM LED: Blinks green to indicate data transfer

8 LEDs for the digital inputs: Blink red to indicate input signal

1 LED for 3.3 V supply power: Lights up red

1 LED for 5 V supply power: Lights up red

1 LED for each switching output,

K1 and K2: Light up green when relay contact is closed

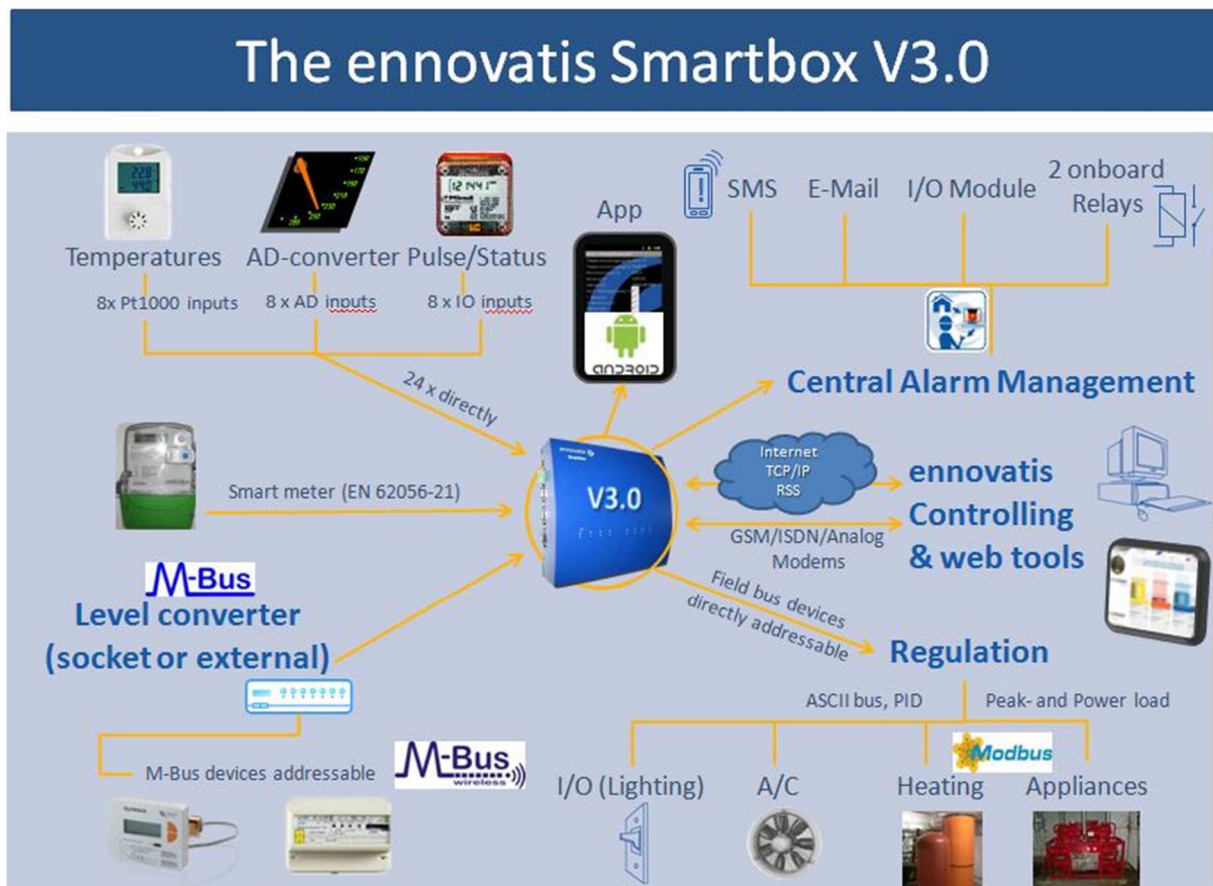


Figure 13. Existing interfaces and protocols of the Smartbox

4.1.2 Concept of hardware systems in dwellings

The technical installations in the dwellings will be mainly radio operated, because cabling was not allowed by the end user. Temperature- and humidity sensors are installed in living rooms and sleeping rooms of the dwellings. The sensors are energy harvesting sensors and use the enOcean protocol to transmit data from the sensor to a Modbus gateway, which is connected to a separate Smartbox installed in the dwelling. Some of the temperature- and humidity sensors are equipped with batteries, because, especially in sleeping rooms the daylight is very rarely to be used by the energy harvesting sensors. As some of the defined scenarios in the EEPOS project are related to load shifting issues, ZigBee smart plugs were installed and connected to household appliances, e.g. washing machines. A TFT LCD display will be used to visualize forecast data for energy prizes and weather. The display will be connected via Modbus/RTU directly to the Smartbox. The Smartbox receives information from the OGEMA system and transmit this information to the installed display. The Smartbox operates in the dwelling as a energy management gateway between the OGEMA platform and the appliances in the dwellings. The Smartbox is connected via the private internet connection of the household. The commands to control specific household devices will be transmitted from the Smartbox through the Modbus/ZigBee gateway (Figure 25) to the ZigBee smart plug. The planned installation is shown in Figure 14.

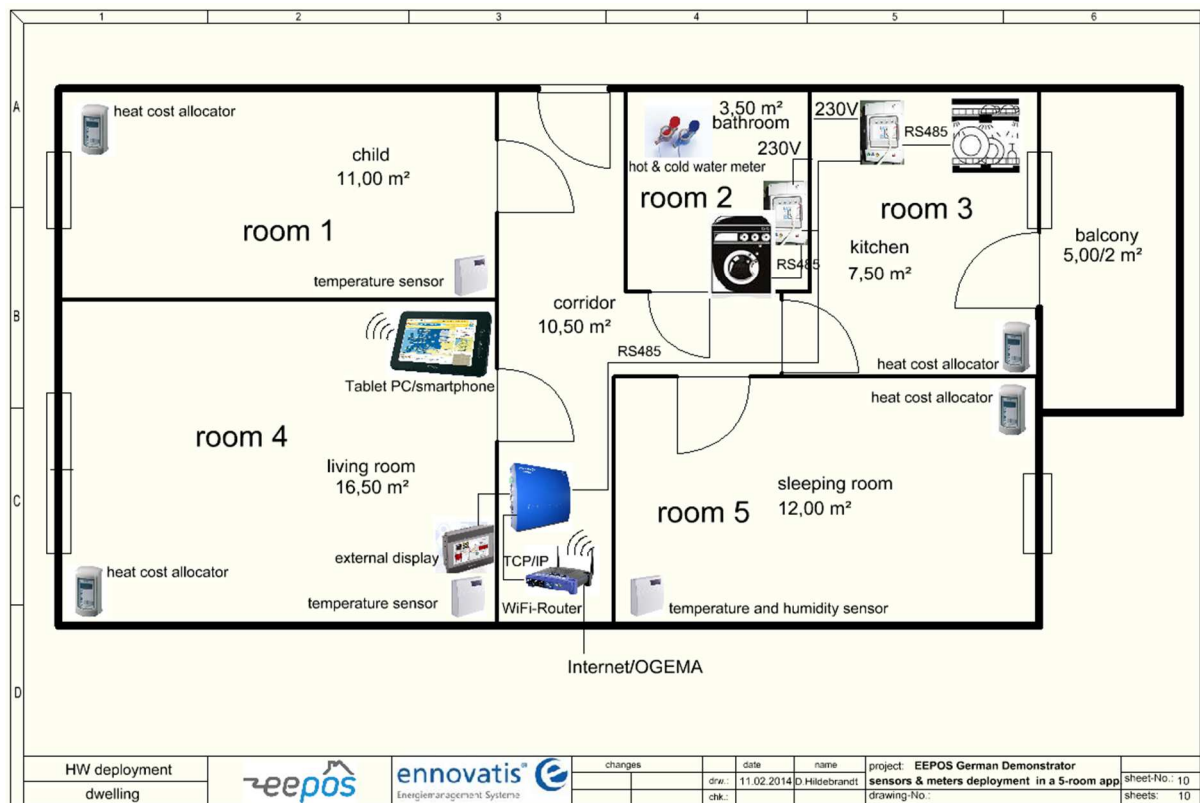


Figure 14. Hardware installations in dwelling

The technical details of the implemented hardware in the German demonstrator is included in the Appendix of this Deliverable.

4.1.3 EEPOS applications

In the German demonstrator applications will be implemented which are described in the deliverable D2.3, which is the OGEMA application to transport data from the NEMS (OGEMA) to the BEMS (Smartbox). The transmitted data will be presented on LCD displays operating in the tenants homes, which contain 24hours energy price forecast information as well as additional information of the weather status and a weather forecast. Furthermore the LCD display will offer the possibility to provide a feedback of planned absence of the tenants, which is useful for the OGEMA system. External software components, like the ZeSAME system, described in D3.3 will help to analyze energy consumption related data from the participating houses and homes. Furthermore applications, like end user collaboration tools, developed in Task 3.4, will be implemented in tested in the demonstrator as soon as they will be available from the project partners, who are developing those tools. The Unity 3D game engine tool, developed in Task 3.4, will provide visualized data of the current and historical energy consumption also for tenants in the German demonstrator.

5. ENERGY BASELINES

In the following section the energy baselines of the renewable energy sources (RES) which are available in the German demonstrator in Langenfeld are analyzed. Measured data, which was obtained by the ennovatis energy management system since September 2013, will be used to calculate energy baselines.

5.1 Energy production

The production of renewable energy in the German EEPOS demonstrator in Langenfeld is currently covered by a district heating system which produces heat locally from biomass (wood chips). Additionally, a CHP was installed which operates currently for the production of domestic hot water (DHW). The building “Martinstraße 1” is additionally equipped with a heat pump, but as no one of the tenants in this building is participating in this project and the heat pump in the building operates quite independent, it was decided not to include this building in the project.



Figure 15. District heating plant Langenfeld

The heat production of the biomass boiler is measured constantly with a heat meter, which is connected to the ennovatis Smartbox. The following parameters are obtained from the heat meter:

- Flow temperature on heat output [°C]
- Return temperature on heat output [°C]
- Heating unit - Power [kW]
- Heating unit - water flow [m³]
- Heat output [kWh]

From the CHP the following parameters are being obtained:

- Flow temperature on heat output [°C]
- Return temperature on heat output [°C]
- CHP Power [kW]
- CHP water flow [m³]

- Electricity output CHP [kWh]
- Heat output [kWh]

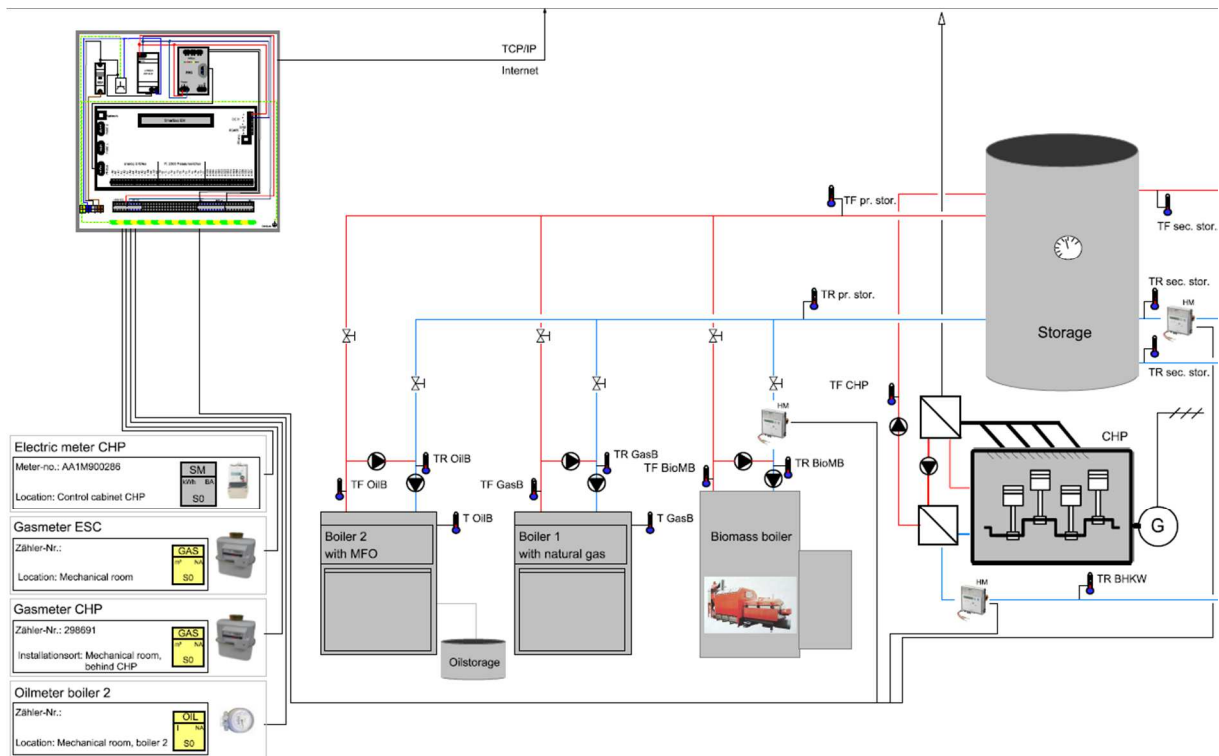


Figure 16. Schematic drawing of the district heating plant and Smartbox connected meters

The following figures show the production of renewable energy since the operation of the Smartbox energy management system, which was installed in July 2013. In July and August 2013 not all meters were connected to the Smartbox, hence the full data is available from September 2013.

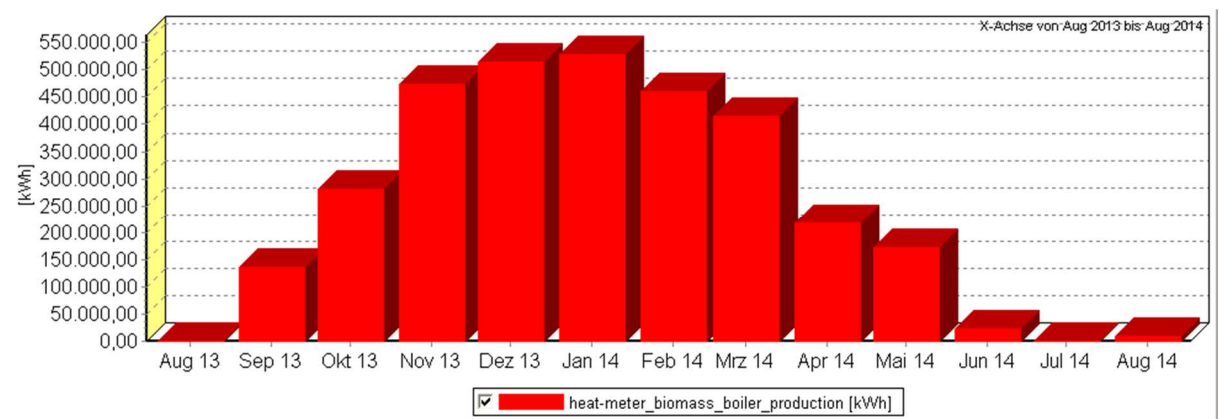


Figure 17. Monthly heat production with biomass boiler

Due to the seasonal different demand of heat energy in the buildings of the neighborhood, the heat production of the biomass boiler varies from month to month. The highest heat production was measured in January 2014 with 525.000 kWh.

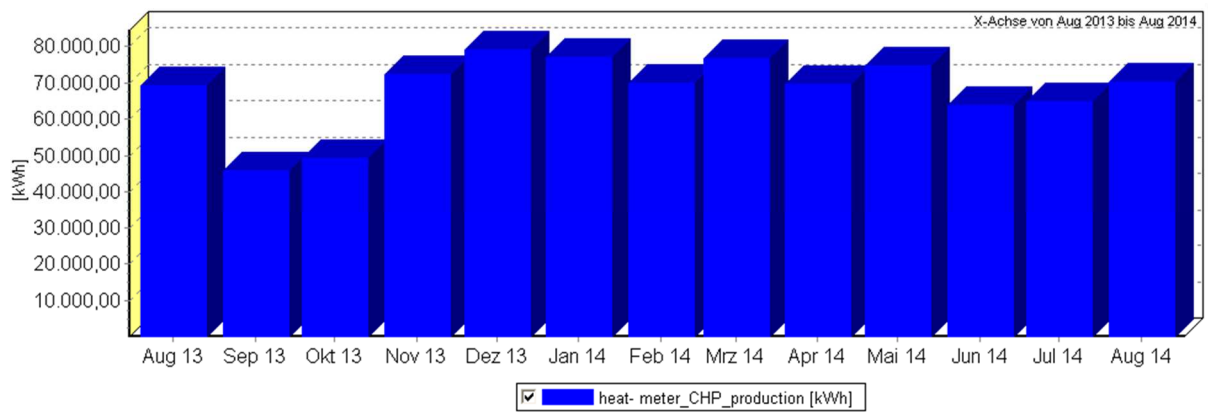


Figure 18. Monthly heat production by gas-operated CHP

In December 2013 the CHP has produced the highest amount of heat with 79.000 kWh.

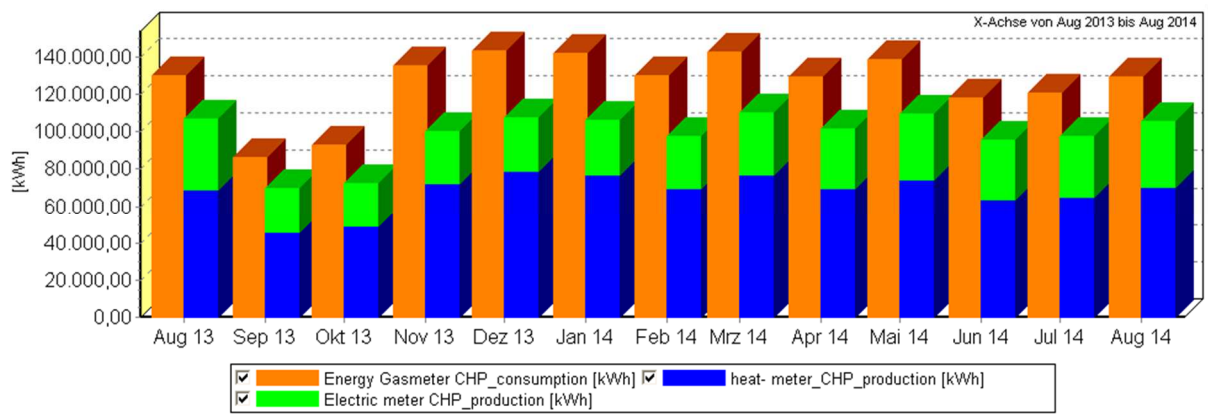


Figure 19. Monthly heat- and electricity production and gas consumption of CHP

The gap between the consumption of gas for the operation of the CHP and the production of electrical and heat energy is caused by the efficiency rate of the CHP itself (Figure 19). The production of electric energy by the CHP is quite constant as the CHP is running 24 hours with constant power. 100% of the produced electric energy is being delivered to the main grid, because technical installations to use the produced energy in the neighborhood were too expensive to be implemented by the housing cooperative BVL.

5.2 Energy consumption

5.2.1 Electricity consumption of participating households

The energy baselines of the ten participants are calculated from measurements of the individual meters, which were installed in September 2012 during the 3E-HOUSES project. As the data collection of those meters is running continuously, the obtained data could be used. The following Figure 20 shows as an example for the other dwellings the monthly consumption data for electricity as well as the arithmetic mean of the monthly consumption and the trend during the measurement period.

$$E_{el,base} \left[\frac{kWh}{month} \right] = \frac{\sum_a E_{el,a} [kWh]}{t \text{ [month]}}$$

Equation 1. Baseline for electrical consumption (historical data available)

Equation symbol	Explanation
$E_{el,a}$	Electric energy consumption of a specific number of months
t	Number of months where historic data was available

The used methodology of the baseline calculation for electricity consumption is taken from the results of the methodology research in the project 3E-HOUSES, which is described in [2]. Hence, the calculation of a monthly value is done with the arithmetic mean value of a specific number of months where historic data is available. It was one of the results of the baseline research in the 3E-HOUSES project that there’s no influence of any other factors then the occupancy of the household on the energy consumption.

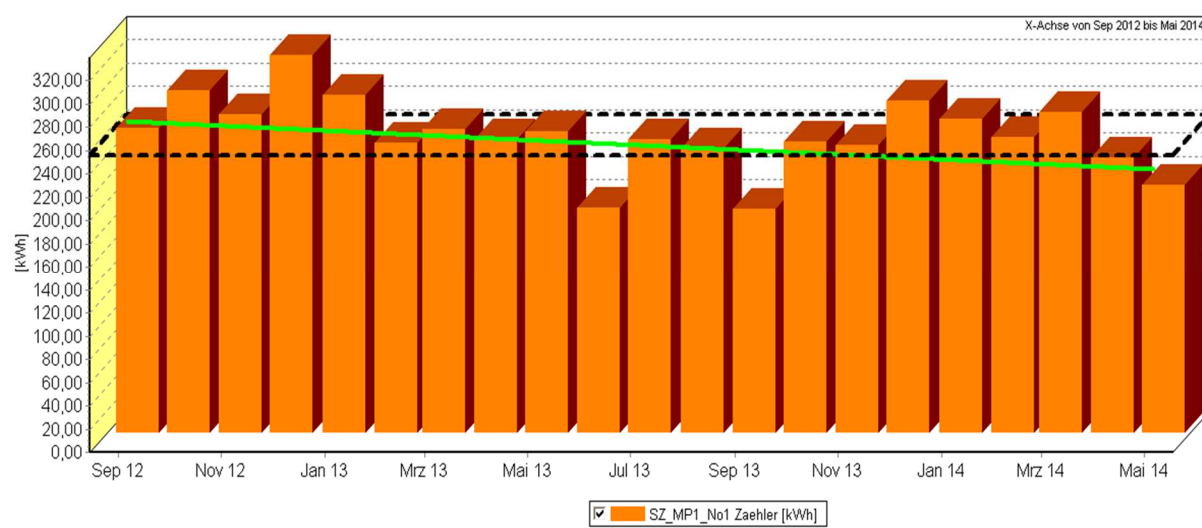


Figure 20. Dwelling No. 1 - monthly electric energy consumption, trend (green) and mean value as example for other 9 dwellings

Dwelling - ID	Baseline Monthly electric energy consumption longtime mean [kWh/month]	Trend of consumption in household since September 2012
1	256,03	decreasing
2	206,8	increasing

3	160,6	decreasing
4	182,0	decreasing
5	191,7	decreasing
6	228 (calculated from new measurements since May 2014)	New meter installed on 27.05.2014
7	238,5	increasing
8	287,5	constant
9	324,1	decreasing
10	146,05	increasing

Table 9. monthly electric energy consumption baseline of dwellings

Load shifting:

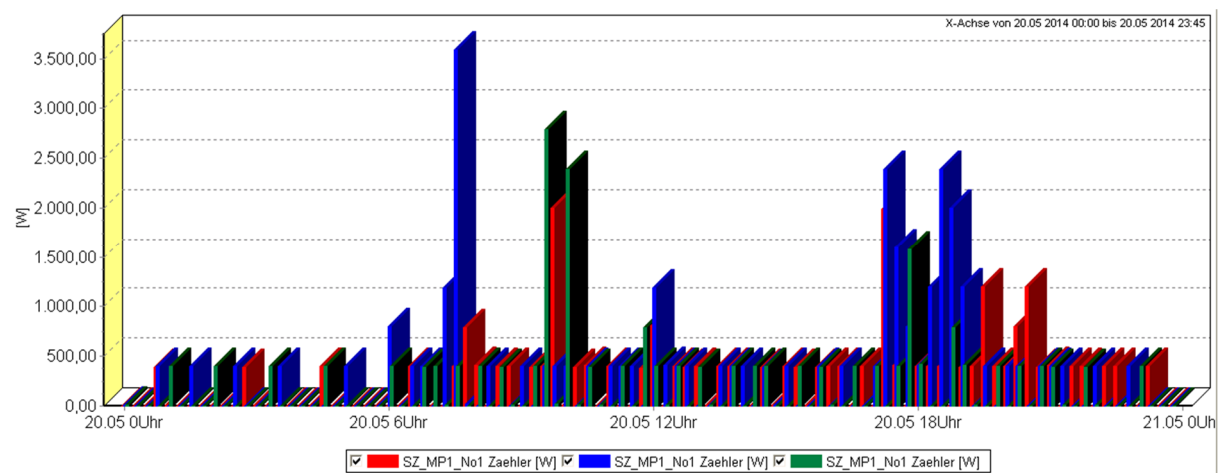


Figure 21. 1/4 hourly electric energy consumption in dwelling No.1 in 3 following days

In Figure 21 it is shown that for example in dwelling No.1 at specific times higher loads of electric energy are occurring. To shift these loads to different times of the day is one of the objectives in the EEPOS project. Anyway, the times of higher loads are different on each day and in each household. The pattern of the curve gives also some information, which appliance is running at which time. In household No. 1 the refrigerator with a power of 400W switches on in a quite constant cycle, which is visible during the night time. In this project the scenario B-3 (C2) “Activities delayed/scheduled by end-user” was created to research the influence of the EEPOS system in relation to load shifting possibilities of the end user. In combination with an incentive of eco points etc., which the end-user can earn, it will be possible to quantify the shifted loads by the comparison of the energy consumption in a 15 min cycle.

5.2.2 Heating consumption of demonstrator buildings

Heat Energy consumption of the building involved in the German demonstrator were analysed based on data from the year before the demonstration, involving data from July 2013 to August 2014 for all heat meters involved, in the houses as well as the heating plant itself for

detailed analysis. As can be seen in Table 10, in some cases the energy needed for domestic hot water can be distinguished from the heating energy demand, as additional heat meters are available.

House ID	Address	Heat	Additional Warm Water
H1	Martinplatz 1-3	Yes	No
H2	Martinstrasse 5-7	Yes	Yes
H3	Martinstrasse 9-11	Yes	Yes
H4	Martinstrasse 13-15	Yes	Yes
H5	Martinstrasse 17-19	Yes	No
H6	Martinstrasse 21-23	Yes	No
H7	Martinstrasse 25-27/Paulstrasse. 4	Yes	No
H8	Martinstrasse 52	Yes	No
H9	Martinstrasse 56	Yes	No

Table 10. Available heat-meters in German demonstrator

A quantitative comparison of the monitored substations and the heatingplant as can be seen in Figure 22 that they only use a small part of the overall energy. In numbers, on the average 18% are used by the households behind these substations.

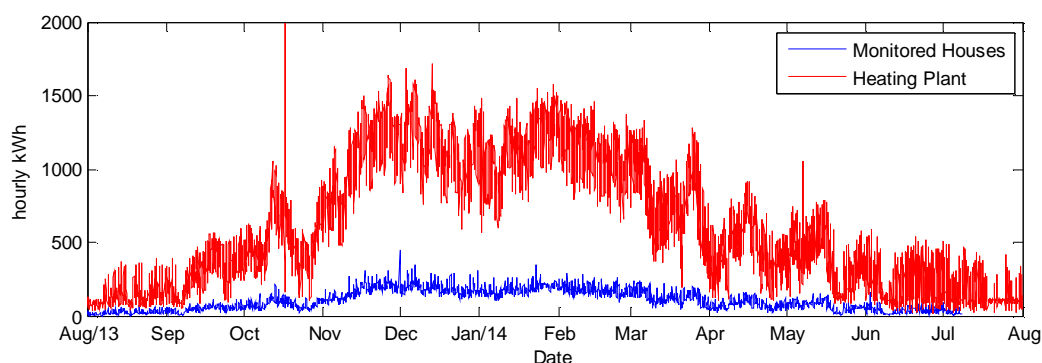


Figure 22. Energy produced by the heating plant compared to the monitored houses

On the other hand, the percentage has a variance as low as 0.0059, and Figure 23 shows that the heat energy consumed by the selected houses has a very good correlation to the energy produced by the heating plant, allowing for the conclusion that their behaviour is representative for the neighbourhood.

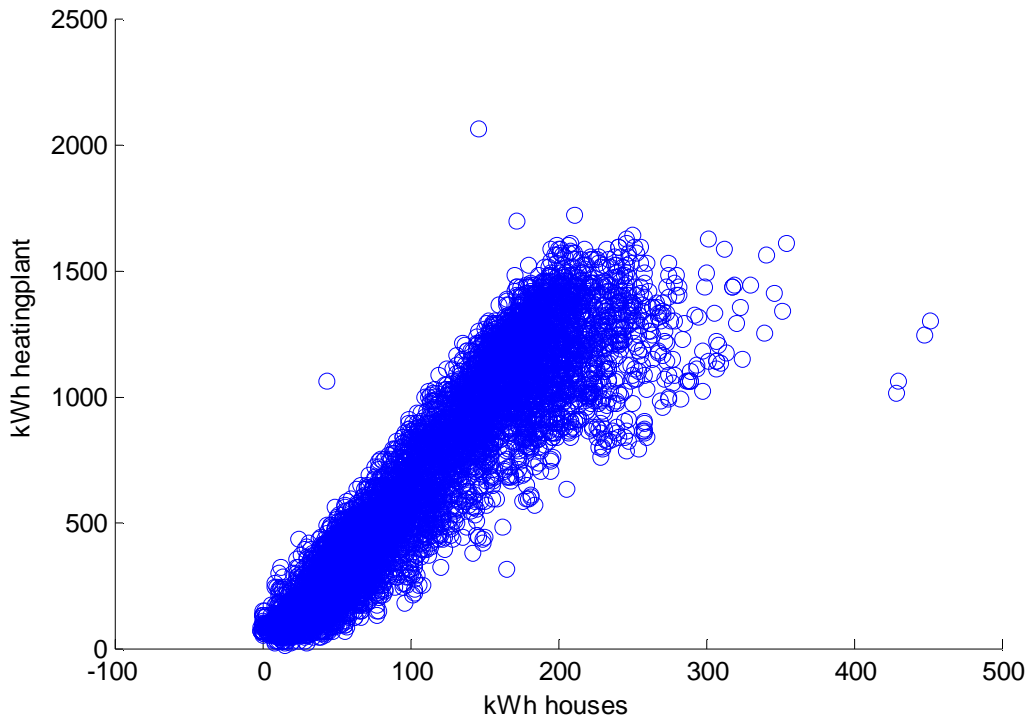


Figure 23. consumption of house relative to production of the heating plant

With respect to load shifting, the behaviour of heating, hot water and undifferentiated meters was analysed on hourly basis over the core of the heating season, October to March. Figure 24 shows a comparison between the houses with split meters and the other showing that the average consumption is not much different when the meters for heating and domestic hot water are added, that the difference between domestic hot water and heating is not significant, and there are no significant morning or evening peaks in energy consumption of the houses used for the demonstration. It has to be noted that the sample rates for the split meters were very low.

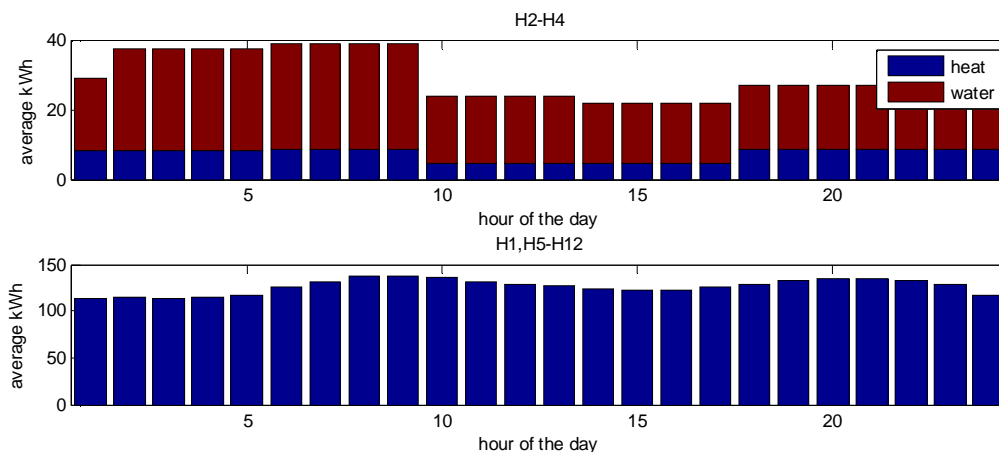


Figure 24. Average consumption per hour of the day October to March

For an overview Table 11 contains on one hand the average sample rate in hours, on the other hand the average thermal energy consumption in KWh per month, to be consistent with Equation 1.

ID	Type	Average Samplerate in hours	Average kWh thermal energy per moth
H1	All	0,26	3176,91
H2	Heating	4,78	3992,28
	DHW	4,38	2353,19
H3	Heating	8,39	4809,49
	DHW	8,39	1828,50
H4	Heating	8,39	4478,83
	DHW	8,40	1642,84
H5	All	0,53	6271,78
H6	All	0,53	6642,29
H7	All	0,74	23185,35
H8	All	0,26	6310,42
H9	All	0,26	4550,81

Table 11. Overview of the thermal energy consumption in the German demonstrator

6. CONCLUSIONS

The first contacts with participating end users in the German demonstrator have shown an uncertainty regarding the automatic or scheduled running of electrical household devices. End users are afraid of loss of their insurance coverage, if appliances will run during their absence or at night and cause any damage in this time. These questions were intensively discussed between the WP5 partners during a number of frequently scheduled telephone conferences and also on consortium meetings during the WP5 demonstrator running time. Resulting of this and due to technical constraints, which are existing regarding the automated control of “white goods” the partners have developed a technical solution, which offers limited, but possible options to shift energy loads in household according to the forecast data provided by the neighbourhood energy management system. The German demonstrator with ten participating tenants, usage of RES and the simulation of the EEPOS tools will try to give answers on these questions and provide important input for the results of the EEPOS project. While the thermal energy consumption data was not as conclusive as hoped, in depth analysis still showed potential for some of the houses, which will be the focus of the demonstrator.

With the measured data of the energy consumption of the ten EEPOS participants and the data of the energy consumption of the buildings we can specify the influence of the EEPOS neighbourhood energy management system in Deliverable 5.4. This will be done by comparing baseline data of this report to measured data which was obtained during the running time of the German demonstrator. The data measurements of e.g. global radiation will provide information about the potential energy production and can be related to the measured energy consumption of buildings and households in the neighbourhood to calculate the needed energy production to achieve an energy positive neighbourhood. This will be done in the final WP5 report D5.4

6.1 Summary of achievements

Due to the high expectations of the end users to technical solutions, which have a direct connection to their private life it is necessary that a solution was developed, which can provide the highest comfort and security in managing the energy consumption. The results of the previous work in work package 4, Task 4.1 showed that an automated control of household appliances is technically not possible in the existing demonstrator homes. Nevertheless a solution to visualize energy forecast data to the end user was developed and will be included in the German demonstrator. The developed solution, using the existing energy management system Smartbox, which is described in this report, is a chosen basis for further developments in this project. Some of the participants in the demonstrator have already a quite low or decreasing energy consumption, which may be caused also by the change of their behaviour related to energy after the participation in the previous project 3E-HOUSES. In this project a main focus was the education of participants and the development of technical solutions to allow energy saving for end users in social housing. It was further proven that the selected houses are representative for the average energy consumption both in quantitative and qualitative behaviour.

6.2 Relation to continued developments

The WP5 is strongly related to the different Tasks in the WP1-5 as all of the findings and developments shall be tested in real life environment. The WP5 can also provide input to WP6 for any dissemination activities. The developments in WP5 will be a basis for further demonstrators, which might be set up in following projects.

7. ACRONYMS AND TERMS

BEMS	Building energy management system
BVL	Bauverein Langenfeld eG (housing association in Langenfeld)
CHP	Combined heat and power plant
DHW	Domestic hot water
EDM	Energy data management
EHCA	Electronic heat cost allocator
M-Bus	Metering Bus
RES	Renewable Energy Source
RF	Radio frequency

8. REFERENCES

- [1] 3e-Houses Guidelines and best practices for energy efficiency in social housing
http://www.3ehouses.eu/sites/default/files/3eHouses_D4-1_Guidelines_and_best_practices.v23.pdf
- [2] Deliverable D1.2 – Definition of methodologies, Rey Porto, Milagros et al.
http://www.3ehouses.eu/sites/default/files/3e-HOUSES_-_Deliverable_1_2_Definition_of_Methodologies_v12Annex.pdf , 22.09.2010

9. APPENDICES

Appendix 1: Technical data of the implemented hardware

- **External TFT LCD display**



Specification:

Construction: plastic molding housing

Display: 4.3" 65,536 color TFT LCD

CPU and core logic: 32Bit RISC 400MHz processor

DRAM: 64 MB DDR2 on board

Storage: 128 MB flash memory on board,

Recipe memory saved in flash memory, RW 512 Kword, RW_A 64 Kword. (User project size: 16MB, Data and Event log size: 48MB)

x I/O: serial ports: Com1: RS-232/RS-485 2w/4w, Com3: RS-485 2w Ethernet Port (10/100 Base-T)

Power input: 24±20% V DC ,250mA@24VDC

Dimension (W x H x D): 128 x 102 x 38mm

Weight: 0.3kg

Software: EB8000 V4.1.0 or later

- **ZigBee/Modbus Gateway:**



Figure 25. ZigBee/Modbus Gateway

ZigBee/Modbus gateway specification:

General characteristics	Chip Ember EM2420 Compatible IEEE 802.15.4 EmberZnet 3.5.x (ZigBee PRO) Stack Modbus/RTU
RF characteristics	Frequency: 2405 MHz ÷ 2480 MHz Modulation: DSSS Nominal transmission power: 1mW (0 dBm) Receiver sensitive: -92 dBm External antenna gain: 5,5 dB Outdoor/indoor range: 100m/30m
Supply	12-24 Vcc/Vca ($\pm 10\%$); 100mA; 50/60Hz
Connections	RS485 with plug off morsels (3,81 mm pitch)
Environment Parameters	Operating temperature: $-10 \div +60^{\circ}\text{C}$; <80% U.R. non condensing Storage temperature: $-20 \div +70^{\circ}\text{C}$; <80% U.R. non condensing Degree of protection: IP 50
Compliant with 2006/95/EEC, 89/336/EEC, 99/5/EEC directives Product law applied	ETSI EN 300 328: Radio Compatibility for digital wide band transmissions ETSI EN 301 489: Radio Compatibility EN 61000-6-2: Electromagnetic Compatibility - Emissions EN 61000-6-3: Electromagnetic

Compatibility - Immunity
EN 60950-1: Electric Security

○ **ZigBee smart plug:**



Figure 26. Adapted smart plug

ZigBee smart plug specification:

General characteristics	<p>Chip Ember EM250 Compatible IEEE 802.15.4 Stack EmberZnet 3.5.x (ZigBee PRO) Modbus/RTU Address settable through radio command</p>
RF characteristics	<p>Frequency: 2405 MHz ÷ 2480 MHz Modulation: DSSS Nominal transmission power: 2mW (3 dBm) Receiver sensitive: -95 dBm Internal antenna gain: 0 dB Outdoor/indoor range: 100m/30m</p>
Supply	90/250 Vca; 1W; 50/60Hz
Measurement	<p>Active Power [W] Active Energy [Wh] Energy consumption measurement time [second]</p>
Relay	<p>250V Contacts Max load: -Resistive: 10A -Incandescent lamps: 10A</p>

Output	-Fluo lamps /transformers: 4A Duration: 100.000 cycles with resistive load Schuko socket, french socket, UK socket, italian socket, US socket Schuko plug, french plug, UK plug, italian plug, US plug
Environment parameters	Operating temperature: 0 ÷ +50°C; <80% U.R. non condensing Storage operation: -20 ÷ +70°C; <80% U.R. non condensing
Compliant with 2006/95/EEC, 89/336/EEC, 99/5/EEC directives	ETSI EN 300 328: Radio Compatibility for digital wide band transmissions ETSI EN 301 489: Radio Compatibility
Reference Norms:	EN 55014-1:2006 + A 1:2009: Electromagnetic compatibility - Immunity EN 61000-3-2:2006: Electromagnetic compatibility - Emissiond EN 61000-3-3:2008: Electromagnetic compatibility - Emissions EN 55014-2: Electromagnetic compatibility - Immunity

o Radio enOcean/ModBUS Gateway

The radio enOcean/ModBUS Gateway collects data wirelessly with 868 MHz radio frequency from the radio temperature and humidity sensors, as well as from the window contacts. The data will be submitted wired via ModBUS interface to the Ennovatis Smartbox.

Receiver interface for radio sensors, respectively keys, based on EnOcean RF technology and controllers, respectively control systems, with RS485 interface.

Direct transmission of all radio telegrams received via serial telegrams to controllers, respectively control systems.



Figure 27. SRC65-RS485 ModBUS Gateway

Technical data:

Power supply: 1524VDC / 24VAC +/-10%

Power consumption: typ 0,6W / 1,5VA

Antenna: External receiving antenna with magnetic holding (included in delivery)

Connector female FME

Terminating resistor: 120 Ohm, available via jumper

Clamps: Terminal screw max. 1,5mm²

Enclosure: Bottom part: material PA6, colour white

Top cover: material PC, colour crystal clear

Protection: IP42 according to EN60529

Ambient temperature: 20...60°C

Transport: 20...60°C / max. 70%rH, non condensed

Weight: 110g (without external Antenna)

Interface: RS485 MODBUS, Master/Slave communication

Baud rate configurable (9600, 19200 Baud)

- **Radio Temperature and Humidity Sensor**



Figure 28. Radio temperature Sensor SR04rH.

Combined sensors for temperature and humidity measurement will be installed in certain less heated rooms (e.g. sleeping rooms) of every dwelling. The data of these sensors will be transmitted via ModBUS Gateway which will be placed in the staircases of the building.

Battery-less radio room sensor for temperature and ventilation control in connection with the receiving interfaces SRCx and higher graded control systems.

Transmission to receiver by means of radio telegrams according to EnOcean standard.

Technical data:

Technology: EnOcean, STM

Transmitting frequency: 868,3 MHz

Transmitting range: approx. 30m in buildings, approx. 300m upon free propagation

Humidity sensor: Range: 0... 100%rH

Resolution: 0,4%rH

Absolute accuracy: +/-3% range 30%...80%

Temperature sensor: Range: 0°C... +40°C

Resolution: 0,15 K

Absolute accuracy: typically +/-0,4k

Measuring value detection: every 100 seconds

Sending interval: ... every 100 seconds if changes >0,8K or >1,6%rH or >14° angle of rotation or slide switch ... every 1000 seconds if changes <0,8K or <1,6%rH or <14° angle of rotation

Energy generator: Solar cell, internal gold cap, maintenance free

Protection: IP30 according to EN60529

Ambient temperature: 25...+65°C

Transport: 25...+65°C/ max. 70%rH, non condensed

Weight: 50g

- **ZigBee sensor for temperature and humidity**

The ZED-THI-M is a battery powered device which perform temperature and humidity measurements at the same time and send them at regular intervals to a Gateway of the 4-noks products family.

This device may be configured to manage alarm thresholds for exceeding maximum or minimum levels of measures.

It is also possible to adjust the sampling and data transmission rate to improve battery life.



Figure 29. ZigBee temperatur and humidity sensor

General characteristics	Chip Ember EM250 Compatible IEEE 802.15.4 Stack EmberZnet3.4.x (ZigBee PRO) Modbus/RTU Device address settable via internal dip-switch
RF characteristics	Frequency: 2405 MHz ÷ 2480 MHz Modulation: DSSS Nominal transmission power: 2mW (3 dBm) Reception sensitivity: -95 dBm Internal antenna gain: 0 dB Coverage outdoor/indoor: 100m/30m
Supply	AA high energy density lithium battery 3,6V/2000mAh Battery life: 3 years in case of 1 transmission per minute at 20°C
Temperature/Humidity Sensor	Sensor used: Sensirion SMD SHT11 series Temperature measurement range: from -40 to 120°C Reading accuracy inside measurement range: +/- 1,5°C max. (view graph) Temperature measurements in tenth degrees Humidity measurement range: from 0 to 100% RH% Reading accuracy +/- 5 RH% max. (view graph)
Environment parameters	Operating temperature: -10 ÷ +60°C; <80% U.R. not condensing Storage temperature: -20 ÷ +70°C; <80% U.R. not condensing Degree of protection: IP 55
Compliant with 2006/95/EEC, 89/336/EEC, 99/5/EEC directives Reference Norms:	ETSI EN 300 328: Radio Compatibility for digitals wide band transmissions ETSI EN 301 489: Radio Compatibility EN 61000-6-2: Electromagnetic Compatibility - Emissions EN 61000-6-3: Electromagnetic Compatibility - Immunity EN 60950-1: Electric Safety

Table 12. Technical data of the ZigBee Temperature and humidity sensor

o Submetering cold water meters for dwellings

The submetering cold water meters are connected via radio to an existing submetering system which is being used at this time for billing. The data of this meter are read out once a day by the submetering gateway which is installed in the building. The Ennovatis Smartbox is connected to this gateway via M-Bus interface and polls the data from this gateway once a day.

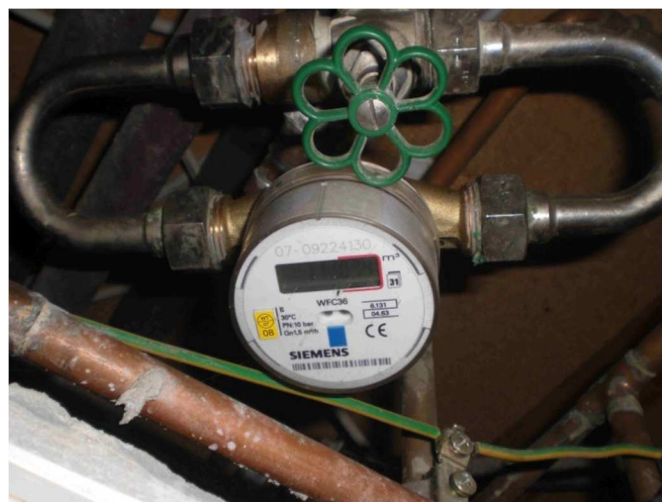


Figure 30. Submetering cold water meter with a radio adapter

The water meter consists of a flow measuring section which houses the impeller and the totalizer. It is designed as a compact unit; the flow measuring section and the totalizer form one unit.

The body of the flow measuring section is made of brass. It houses the measuring chamber with the single-jet impeller. The inlet has a sieve to retain larger dirt particles.

The flow measuring section carries the totalizer which is a dry running meter. It is protected by a transparent plastic cover. The water meter indicates the actual consumption with an 8-digit totalizer. It has an indicator for the current water consumption and a rotating wheel for the indication of flow.

The meter operates based on the single-jet measuring principle where the water jet hits the impeller tangentially. The impeller's speed is sensed magnetically by a GMR sensor.

Measurement accuracy class (DIN ISO 4064/1)			
Horizontally	B		
Vertically	B		
Unit	m ³		
Flow rates	1.5 m ³ /h		2.5 m ³ /h
Min. flow rate Q_{\min} H / V	30 l/h	50 l/h	
Lower limit of flow rate Q_t	120 l/h	200 l/h	
Nominal flow rate Q_{enn}	1,500 l/h	2,500 l/h	
Max. flow rate Q_{\max}	3,000 l/h	5,000 l/h	
Starting flow, horizontal	6 l/h	10 l/h	
Max. perm. operating pressure	10 bar		
Range of use of flow measuring section	1... 90 °C		
Behaviour in the event of excessive flow			
Flow rate = 2 q_{\max}	linear		
Flow rate > 2 q_{\max}	constant		
Perm. ambient temperature			
Transport und storage	5...55 °C		
Operation	max. 55 °C		
Degree of protection	IP 64		
Battery life (depending on strain of the battery)	12 years + 6 months (storage),		
Connections and weight	1.5 m ³ /h	1.5 m ³ /h	2.5 m ³ /h
Pipe connection (inlet and outlet)	¾"	¾"	1"
Mounting length	80 mm	110 mm	130 mm
Weight	0.55 kg	0.6 kg	0.7 kg

Table 13. Technical data of the cold water meter Siemens Type WFC36

o network nodes WTX.16

The network node is at the core of the remote readout system, receives the consumption data from the meters and distributes them within the network. Each individual network node can provide all the values for reading out because of their ability to communicate with each other. Values are read out on-site at any network node via a cable connection or per radio from any point within the transmission radius. The used gateway allows remote meter readout by the Ennovatis Smartbox via M-Bus interface.



Figure 31. Submetering gateway

Technical Data:

CE conformity to EMC directives	
Safety class	IP32
Safety class	2
Electromagnetic compatibility	immunity: EN 55 024/EN 301 489 emissions: EN 55 022/EN 300 220-1
Operating voltage WTT16...	DC 3.6 V
Lifetime of main battery	> 5 years
Operating voltage WTX16...	AC 100...240 V, 50/60Hz
Rated frequency	868.3 MHz
Transmitter power	< 14 dBm
Frequency of transmission	<1%
Perm. ambient temperature	
Transport and storage	-20...+60 °C (< 30°C recommended)
Operation	0...55 °C
Weight	0.3 kg

Table 14. Technical data of WTX16

o **Electricity Meters**

The existing analogue meters cannot be used to collect data of the electrical consumption by the ennovatis smartbox. Therefore, additional sub meters will be installed to measure the electrical energy consumption in parallel with the existing analogue meter which will be maintained by the local energy provider. With the installation of a separate smart meter measurements can be carried out independently. These sub meters have an M-Bus interface and provide measurement values in a 15min cycle.



Figure 32. Sub meter Type: EMH-KIZ

Technical data of the electrical meter EMH Type KIZ:

Voltage 4-wire meter 2-wire meter 3 x 230/400 V 230 V

Current 0,25 - 5(65) A or 0,5 - 10(65) A

Starting current 20 mA

Frequency 50 Hz

Accuracy active energy Cl. B acc. to EN 50470-1, -3

Measuring types active energy +A (with non-reverse ratchet)

Meter constants LED output 10 000 Imp./kWh 100 Imp./kWh

Energy registers number max. 2 tariff registers (T1 / T2)

Control input for tariff switching (optional)

Data retention time without voltage in the EEPROM, at least 20 years

Display version: LCD

Data interface (optional) M-Bus acc. to DIN EN 13757-2, -3 (300...9600 baud)

Output (optional) S0-output

Energy supply switched-mode power supply 3-phase from the measuring voltage

Power consumption per phase < 0,55 VA / < 0,4 W

EMC-characteristics isolation resistance surge voltage resistance against HF-fields

isolation: 4 kV AC, 50 Hz, 1 min

EMC: 4 kV, impulse 1,2/50 μ s, 2 Ω ,