SQUARE – A System for Quality Assurance when Retrofitting Existing Buildings to Energy Efficient Buildings

WP6 -National Pilot Project Austria

Final report

Supported by

Intelligent Energy Europe

SQUARE

SQUARE – A System for Quality Assurance when Retrofitting Existing Buildings to Energy Efficient Buildings

Pilot Project´s Final Report

WP 6

Austria

Deliverable 6:1
Report on the results and experiences from pilot project

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Preface

This internal report is part of the work carried out within the SQUARE project (EIE/07/093/SI2.466701), which stands for A System for Quality Assurance when Retrofitting Existing Buildings to Energy Efficient Buildings. The project is co-funded by the European Commission, supported by its Programme Intelligent Energy Europe (IEE). The SQUARE project aims to assure energy efficient retrofitting of social housing with good indoor environment, in a systematic and controlled way.

The partners of the SQUARE project are:

- AEE Institute for Sustainable Technologies, Austria
- EAP Energy Agency of Plovdiv, Bulgaria
- TKK Helsinki University of Technology, Finland
- Trecodome, Netherlands
- TTA Trama Tecno Ambiental S.L, Spain
- Poma Arquitectura S.L., Spain
- SP Technical Research Institute of Sweden, Sweden
- AB Alingsåshem, Sweden

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Effective date: February 2010

Abstract

The QA system for efficient energy use and improved indoor environment is applied in national pilot projects involving retrofitting and renovation of social housing.

The Austrian pilot project had been selected for the reason that it represents typical social housing structures of Austria. The building stock of 3-4 stored multifamily–houses built in suburban areas or small-towns in the 1950s, 1960s and 1970s has a large amount. Feasible solution-sets for renovation have a great potential for multiplication.

The Austrian pilot project comprises the retrofitting of multifamily apartments near Graz. The AEE INTEC is involved as a consultant during the planning and construction work. The report should describe the situation and procedures within the different stages of implementation of QA system.

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Appendices

1 Introduction

1.1 Objectives and target buildings

The innovative renovation project „Dieselweg“ had been selected as Austrian SQUARE pilot project – due to the following reasons:

- It represents the typical social housing structures of Austria
- The building owner´s policy is oriented on quality assurance and has an intention to realize innovative concepts.

Why is it typical? The building stock has 3-4 stores. The area is suburban (can be compared with the situation of small towns in Austria) and the buildings were built in the 1950s, 1960s and 1970s. These building structures are found in a great number in Austria. Therefore feasible solution-sets have a great potential of multiplication.
This report describes the situation before retrofitting and the procedures and details on how the quality assurance system supported the entire renovation procedure.

In former days the existing building-stock was called „Steyr-Daimler-Puch residential area“ (Steyr-Daimer-Puch is a - also former famous – car company in the south of Graz). Since the time of construction no improvement measures had been carried out.

Picture 1: Situation of the residential area Dieselweg before renovation – 2008 (Source: AEE INTEC)

1.2 Scope and limits

The existing situation of the energy performance, the building structure and the living comfort was really bad. Therefore the GIWOG wanted to carry out a renovation. But an essential problem had to be solved: The flats were occupied and there was no feasible possibility to relocate the tenants during the construction stage.

Therefore it was the first and most formative intention of the GIWOG to find a solution set which could realize the very ambitious objectives: to carry out a high-performance renovation while all tenants could remain in their apartments.

But additionally the project aimed to optimize all processes from planning - production (pre-fabrication) – assembling and transport. The builder GIWOG together with gap-solution, wanted to reach innovative and economical renovation procedures, which could lead to serial pre-fabricated renovation modules.

Therefore the closer scope for the renovation was defined:

- High performance renovation – passive house standard
- Tenants remaining in their apartments during renovation works
- Renewal of the housing services (heating, dhw)
- New introduction of ventilation systems

Following limits were set:

- No additional measures inside the building (except elevators)
- No additional measures inside the apartments except the ventilation devices, the integration of balconies and replacement of windows

Additionally the project-scope was:

- To establish new, innovative and economical renovation procedures
- To improve renovation quality
- To reach an user acceptance for high-performance renovation
- To establish more awareness within housing associations for sustainable and energy-efficient renovations

2 Background

2.1 The location

The aerial photo (Picture 2) shows the location of the residential area – it is in the southern suburban area of Graz – the capital of Styria.

Picture 2: Aerial picture – detail of municipal area in the south of Graz. Source: gis2- digital atlas Styria www.gis.steiermark.at, download 03.03.2009

The residential area comprises five single buildings and one long building-row, totally 204 apartments, situated in three different types of buildings (see Picture 3 and Table 1).

Picture 3: Aerial picture – detail site plan residential area "Dieselweg". Source: gis2- digital atlas Styria www.gis.steiermark.at, download 03.03.2009

The site plan in Picture 4 shows the five single buildings (built in the 1960s and 1970s) and one long building row built in the 1950s (the eldest one).

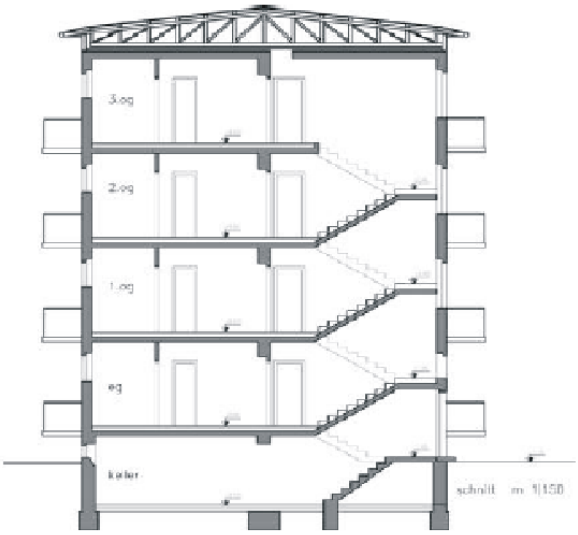
Picture 4: Site plan showing the three phases of the retrofitting process, (Source: Site plan Hohensinn Architektur ZT GmbH; Modification AEE INTEC; Pictures: GIWOG(2), AEE INTEC(1))

2.2 The building structure

The mentioned five single buildings have 4 stores and a cellar. The building row has 3 stores, and occupied attic and a cellar.

Phase	Picture	Year of Construction	Net Floor Area [m2]	Number of Apartments	**Heat Demand** (calculated PHPP) in [kWh/m2.y] **BEFORE**
1.		1970	1.240	3x16	184
2.		1959	1.298	2x19	225
3.		1952	858	9x14	142

Table 1 : Overview on the three different building typologies – figures and separation to the three renovation phases
(Source figures and pictures: "Antrag Haus der Zukunft", Design: AEE INTEC)



Picture 5: Cross-section - building structure before renovation
(Source: Schemes: Hohensinn Architektur ZT GmbH)

Picture 6: Ground plan - building structure before renovation
(Source: Schemes: Hohensinn Architektur ZT GmbH.)

On the floor plan the one of the five single buildings is depicted. One centralised staircase exploits the building. 4 flats are grouped around this staircase. Each single flat is equipped with a balcony. The main structure is massive, the walls made of brick or concrete brick and the ceilings are made of reinforced concrete. The slabs for the balconies reached out without thermal separation – causing thermal bridges.

The 212 flats are all rental units. The heating supply was decentralised, and 13% of the flats were heated by solid fuels, 33% by fuel oil and 54% by night electricity storage heaters. So the running costs for electric power, space heating and hot water generation were paid by the tenants (according to their actual consumption).

3 QA system management

3.1 The Builder - GIWOG

The "GIWOG" – "Gemeinnützige Industrie Wohnungsaktiengesellschaft" (non-profit industry - housing association) was founded 1948 as a subsidiary company of the "VOEST". (The VOEST is one of biggest Austrian steelproducing companies). 1976 the GIWOG merged with the housing association "WAM" (Alpine Montan). 1992 shares were acquired from the "GEMYSAG" (a non-profit housing association in Kapfenberg, Styria) and the "SAG" (the non-profit housing association Schwarzatal, Lower Austria).

Picture 7: Website "GIWOG". (Source: http://www.giwog.at, download 03.03.2009)

Now the GIWOG administrates about 33.000 units, located in the states Upper Austria, Lower Austria, Styria and Vienna. 1996 the GIWOG was converted to a stock company.
In the early stages the GIWOG was the builder for employees of the VOEST, but now the building activities and housing supply is done without specification.

3.2 QA-General policy of the builder

The general policy of the GIWOG is focused on a comprehensive and sustainable quality appreciation. This comprises the improvement of the living comfort (indoor and outdoor environmental quality), gaining cost efficiency and reduction of energy consumption.

But it is also an intention to look after the security of the occupants and their belongings. Building measures are implemented according to requirements of the handicapped (for the purpose of the normative regulations ÖNORM B 1600 and B1601 – barrier-free building). Therefore – by implementing retrofitting measures on old stocks – it is usual to install passenger lifts and avoid or remove barriers (e.g: to enlarge entrance width, to gain plane floors without steps).

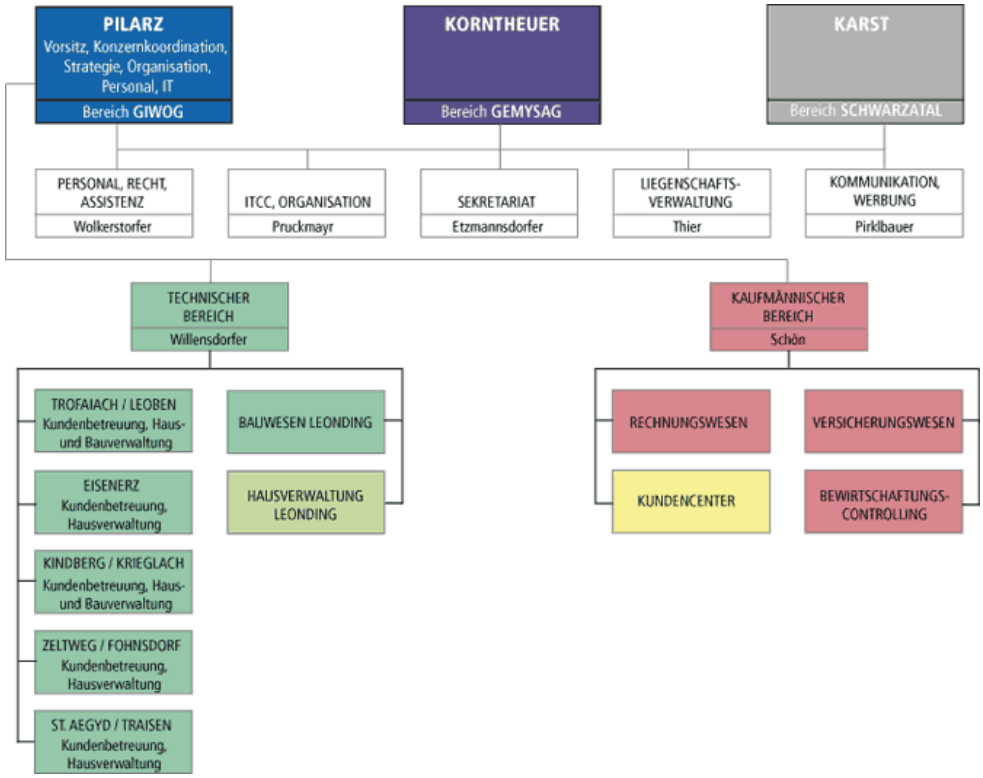
The policy and efforts of the GIWOG within the energy-efficient retrofitting were rewarded several times: "Energystar 2006", Austrian Price for Architecture and Sustainability, Energy Globe

Upper Austria 2006. The Federal Government of Upper Austria evaluated 2006 the first time all housing associations of Upper Austria and the GIWOG could place first.

3.3 Organization chart of the builder

The organization chart of the GIWOG as builder is shown in Picture 8. The company is subdivided into a commercial and a technical department and has staff-positions for IT, communication and marketing, personnel administration and property management.

Account management has a great importance within the GIWOG. So several customer centers and field offices located in Leonding and Trofaiach, in Eisenerz, Zeltweg, Kindberg and St. Aegyd should provide a quick and on-site contact-point.



Picture 8: Organisational chart, of the"GIWOG", (Source: www.giwog.at, download 03.03.2009)

3.4 Cooperative partners for the QA system implementation

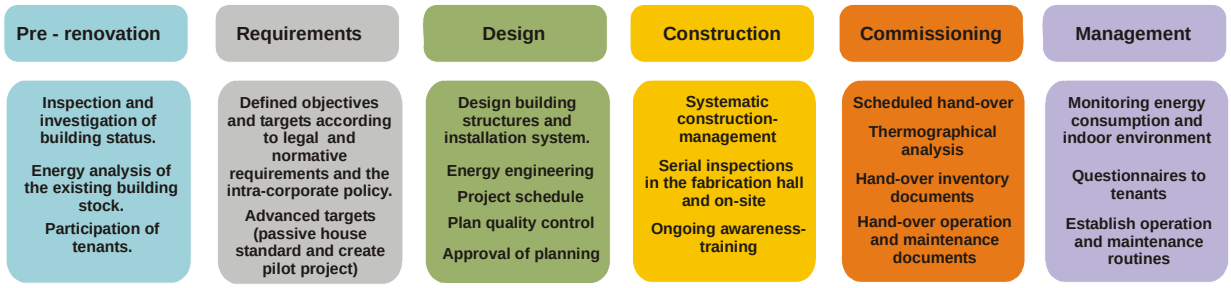
Following companies are pointed out here as most important ones, but there are a lot of more companies involved doing the construction on-site.

Builder:	GIWOG, Gemeinnützige Industrie-Wohnungs AG, Linz
Architect:	Hohensinn Architektur ZT GmbH, Graz
Statics:	Strasser Bau GmbH
General Contractor:	gap-solution GmbH, Leonding
Subcontractor:	Kulmer Holz – Leimbau GesmbH, Pischelsdorf
Subcontractor:	FUTUS Energietechnik GmbH, Perg
Energy engineering:	TB Aschauer, Leonding
Consultant:	AEE – Institute for Sustainable Technologies

4 Methods and accomplishment

4.1 General QA strategy

The general strategy for the renovation process follows the structure of the SQUARE- QA- system. The EN 16001 (which is based on the EN 14001 and the EMAS) is now valid and available in Austria. The essential parts and stages of the national approach – according to the EN 16001 - are very similar to the SQUARE QA system.



Picture 9: Overview of SQUARE QA system

Picture 9 shows the several steps of the renovation procedure – from the beginning. The QA for the renovation of residential area "Dieselweg" mainly follows these steps. The essential parts are the same.

4.2 Establishing pre-renovation conditions

After the decision to carry out the renovation the GIWOG prepared seriously all necessary settings and an innovative concept were initiated together with gap-solution.

Pre - renovation

Inspection and investigation of building status.

Energy analysis of the existing building stock.

Participation of tenants.

The steps after the decision to carry out a retrofitting had been:

- Getting in contact and building up the cooperation between partners for the project group – everybody in this group has been approved to develop innovative concepts.
- All necessary steps to set up a pilot project were prepared
- A project team for the planning was established.
- The office "Hohensinn Architektur ZT GmbH" was assigned to do the primary investigation (similar to the TPI) – an analysis of the building structure and the weak points.
- The technical office of Mr. Aschauer was assigned to elaborate the first energy analysis

The results of the primary investigation – the analysis of the building structure and the weak points are mentioned in chapter 2.2 on page 12.

The communication to the tenants was done by the GIWOG as responsible builder.

4.3 Formulation of requirements and targets prior to renovation

After the primary investigation the next step was to define the requirements and objectives.

Requirements

Defined objectives and targets according to legal and normative requirements and the intra-corporate policy.

Advanced targets (passive house standard and create pilot project)

Due to their quality policy the GIWOG focuses on comprehensive and sustainable quality appreciation within renovation projects. Their policy leads the improvement of the energy – efficiency, but they also want to improve the indoor quality and social environment.
The latter mentioned objective is to improve not only indoor living quality but also outdoor living quality - the keyword: "from a bad environment to a new identity".

So three objective-groups can be defined: Objectives to improve energy-efficiency, objectives to improve the quality of indoor environment and objectives to improve users' comfort – to meet social aspects.

Afterwards the three key-objective-groups were pointed out in detail:

The energy-efficient objectives were defined:

- To reduce the energy demand for space heating about 90 %
- To reduce the running costs for hot water generation
- To reduce the green house gas emission
- To eliminate construction damages and thermal bridges

The objectives to raise the quality of indoor environment:

- Installation of single room ventilation fans with integrated heat-recovery to get adequate air quality
- To install a centralised heating system – based on renewable energy sources
- To use solar thermal systems for hot water generation
- To increase the living space
- To get barrier-free access to all flats by installation of passenger lifts per each building

Additionally the following social aspects had been considered:

- All occupants should remain in their flats during the construction works
- The occupant's comfort has to be improved (increased indoor living quality)
- The living quality within the quarter has to be upgraded (increased outdoor living quality)

The requirements were identified according to legal and normative rules, according to the general policy of the builder within "Energy and Indoor Environment" and "Extraordinary requirements"- the passive house standard.

Comparing requirements, objectives and the current status of the existing building stock – it was clear –single measures will not lead to a satisfying solution: a major renovation had to be carried out. In Austria it is called a "comprehensive renovation".

4.4 Design

Design

Design building structures and installation system.

Energy engineering

Project schedule

Plan quality control

Approval of planning

- 3D–on-site measurement of building façade (laser scanning)
- Design of the entire building structure by "Hohensinn Architektur ZT GmbH", HVAC - Engineering consulted by the AEE
- Drafts for solution-sets for the façade and roof modules
- Energy engineering by the technical office Aschauer
- Development of the pre-fabricated module by the technical office "gap-solution"
- Applying the building permit.
- Approval of the detailed composition of the modules by the building physician, consulted by the AEE INTEC
- Design of the detailed drawings, consulted by the AEE INTEC
- Tendering procedure and placing of orders

Right before the beginning the objects of building stock were separated into three different sections according to their construction time and the building structures. So every section has similar conditions and structures.
The development until applying for building permit proceeded parallel for all three sections – so the planning process took care of three different building conditions, but was done at once and could be managed in an easy way.

In the beginning (see 4.3, page 17) very ambitious targets were defined - How could these ambitious targets be accomplished?
Two main subjects were identified: an innovative building envelope and an innovative energy concept. The building envelope designed by the architect in coordination with the development of the module.
Architect Hohensinn translated the first ideas into an innovative design, which met the objectives and targets established by the GIWOG.

The whole building envelope is fitted with a new cover – with pre-fabricated façade modules. The new envelope also integrates the former balconies into the conditioned building unit. New rooms like "conservatories" enlarge the net area of the single flats. The roof structure was renewed. The roof and the cellar ceiling were also insulated.

Picture 10: Prototype for integrated window

Picture 11: Prototype facade modules

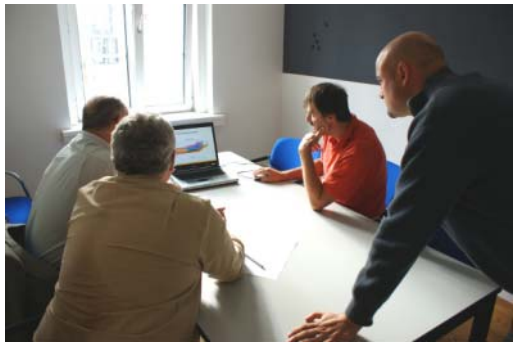
(Source both pictures: AEE INTEC)

The key focus - to reach innovative, new and economic methods for renovation processes – was on the development of pre-fabricated modules. Therefore all necessary steps within this development were undertaken with great attention: Based on the primary investigation a 3D-on-site measurement of each facade was done. It was very important to get real dimensions for the development of the facade modules. After the first drafts there had been a lot of meetings within the project group to discuss the details and to find solution for detailed problems. The AEE INTEC had to supervise decisions within the building physics.

The project timetable was established in a very early stage. It was structured to get an optimized work-flow
(see chapter 6, page 26).
The primary draft and planning, the detailed planning, tendering, the placing of orders and the applying fro building permit were implemented for all 3 stages at once. Afterwards - the construction process was separated into 3 stages due to the different structures of the buildings.

4.5 Training

On October 15th – a presentation held by the head of the measurement department of the AEE INTEC – Mr. Waldemar Wagner should raise the awareness for quality checks after the finished construction works. The best possibility to prepare monitoring and measurements of the building performance is during the construction stage.



Picture 12: Presentation and awareness rising for the coming monitoring procedure (Source: AEE INTEC)

4.6 Site management and follow-up during work stage

The construction management is implemented according to the system established in Austria (following several normative rules for the building construction works like ÖNORM B 1801 and the EN 16001):

Construction

Systematic construction-management

Serial inspections in the fabrication hall and on-site

Ongoing awareness-training

- Regularly site consultation meetings
- Systematic communication structures
- Regularly on-site inspections of the different experts – each responsible for his defined department.
- Inspection and approval of the prototypes of the pre-fabricated modules in the fabrication hall.
- Production of the single modules according to the on-site measurements and detailed drawings.

A systematic construction work management considers the procedures on-site – visible for everybody, but also the assembling process in the production hall. It was important to assemble a prototype of the module which was inspected and approved by the project group.

Picture 13: Construction site blackboard. (Source: AEE INTEC)

The construction works (splitted into the already mentioned three construction stages) were defined and followed sequence by sequence as:

- Demolition works
- Installation passenger lift
- Prearrangements facade, cellar, plinth
- Mounting facade and roof modules
- External works

The continuous inspections on-site were very important to check some details, which were identified as critical points during the planning process. One of these is to get an airtight envelope – to ensure an optimized operation of the ventilation devices. So it was important to have a look if the vapour barrier foils are closed before the window-reveals were covered with gypsum plaster boards.

Picture 14: Window reveal with vapour barrier foil (Source: AEE INTEC)

Another detail which was inspected seriously was the corner-joint between single modules. The insulation was brought in on-site and the vapour-barrier had to be closed to ensure the airtight envelope.

And even during the ongoing construction work the builder approved the quality of the building envelope by thermo graphic photos.

4.7 Commissioning and user's information

Commissioning

Scheduled hand-over

Thermographical analysis

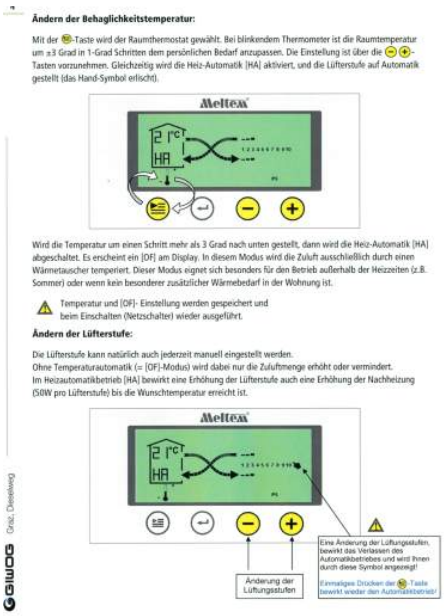
Hand-over inventory documents

Hand-over operation and maintenance documents

The commissioning of the whole project is a formal act between the contractor and the builder. A major focus was on the commissioning of the entire heating system, because the energy concept is not a usual one. So the installer (FUTUS) – together with gap-solution was very busy to finish the system for the operation.
For the commissioning it was also necessary to approve if the requirements are fulfilled. The manufacturer KULMER BAU commissioned a Blower Door Test. And the GIWOG herself, owning a thermo graphic camera – checked the assessment of the thermal envelope – especially inside the flats.
All apartments at Dieselweg are equipped with single-room ventilation devices. This is a very new technique for the tenants, because until now they have been used to their single heating devices and opened the windows for ventilation. But a representative of gap-solution did the commissioning of every ventilation device in the single flats and is up to now currently available for every tenant to make adjustments if somebody has complaints.
To handle a ventilation system is not very familiar to everybody – especially a lot of elder people live in the residential area and a ventilation system with heat recovery means to change the user's ventilation behaviour. Therefore the GIWOG prepared a printed brochure, a user manual to give information about key topics to the tenants.

The issues of the user manual are:

- How does the house work?
- Windows and ventilation
- Balconies
- Space heating
- Common mistakes
- Health
- How to handle the ventilation device
- How to change the temperature?
- How to change the ventilation rate?



Picture 15: User manuals – how to "use" the new apartment (Source: GIWOG)

4.8 Performance assessment, monitoring and management

Management

Monitoring energy consumption and indoor environment

Questionnaires to tenants

Establish operation and maintenance routines

The energy flows for heating and hot water preparation can be controlled via an internet data base (password-protected)
This means a large amount of data, very interesting, but what is do with this enormous number of information data?
So the AEE INTEC made a draft in cooperation with gap –solution. Gap– solution installed a various number of temperature and humidity sensors – even in-between the modules – which are transferring wireless monitoring data to an external data base. Our draft comprises a holistic performance assessment.
Again we pointed out at first our objectives – which do we think are the main relevant parameters?

Then we identified the subjects in detail, which we wanted to evaluate. They comprised the energy performance and energy flow, the comfort parameters and user's satisfaction, the quality assurance and optimization possibilities.

Last but not least we discussed the methodology and which measurements and data are already existing or available or which need to be measured during the next year.
The evaluation and measurements should illustrate both what has been done well and what areas need more research and development.

5 Focus areas for the QA system implementation

5.1 Identified success factors in the implementation work

The SQUARE project pushed the standard of refurbishment to more ambitious targets and received presentable renovated buildings with the demonstration project "Dieselweg". The success is founded in the new renovation technology and the shape and sight of the buildings. QA applied in renovation procedures are thought to be costly in terms of work and effort. But the advantages of implementing a QA system are visible by realised projects. So the Dieselweg is a good example to show the potential within renovation procedures.

Experiences from design, construction and operation of these pilot projects were discussed, summarized, evaluated and disseminated among the SQUARE partners and to other target groups. A lot of interested parties and experts visited the "Dieselweg". But also the tenants are satisfied, that they could remain in their apartments. A lot of them watched all construction processes on-site with great interest. And after finished works they have a very good picture in front of them:

Picture 16: The last part of the long building row is owned by different owners. They did not want to join the renovation – so their building remained as before. Even the space heating is like it was before; everybody has to care for himself/herself (Source: AEE INTEC).

So it is QA which helps new renovation strategies to be implemented successfully for both – builders and users. Additionally QA supports smartly renovation processes. Of course the time-span and the effort for preparing and planning is bigger than usual – but in the end it helps to save time. (See chapter 6, page 26)

5.2 Identified barriers or difficulties in the implementation work

One identified difficulty is the selection of the right technical solution (especially within the HVAC –systems). It was a very intensive process to find an appropriate solution. The difficulty is the innovative component – there are few experiences with new concepts. So first it is hard to convince a builder, a stakeholder and tenants to trust in new technologies. Even the best QA system can not prevent from a long and difficult commissioning phase – but we need ambitious builders and tenants daring to go new ways.

The second identified difficulty is a financial aspect. It can be solved easily if it is considered in the earliest stage of the process. It is necessary to raise the rents if the flat-standard is raised. The GIWOG calculated, that the rent had to be raised about 30 to 40 € (per one 60m^2-flat)- the calculation is resulting from the increment of 1,46 € per square meter for the fee covering the

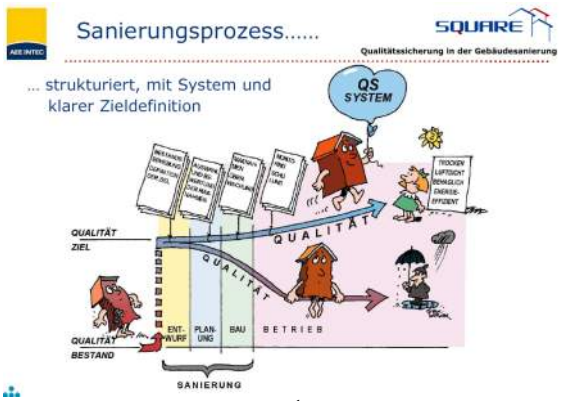
maintenance and improvement-costs. (Source: Kleine Zeitung 11.04.2008). But the occupants could be convinced to vote for the renovation, because the running costs will decrease about 100 € per month. This calculation is effecting an economy of about 60 – 70 € per flat.
It is necessary to consider such financial matters and to inform the tenants from the beginning. But most important – in the end the promises of reduced costs had to be kept by the builder. Therefore the importance of a good quality assurance during the whole process is obviously.

5.3 Dissemination potential within the organisation and within the national scope for relevant stakeholders

The housing association "GIWOG" as builder was provided with a good existing QA-System. But - as mentioned before – continual improvement is necessary. The first decision to create a pilot-building as a show piece project was based on the innovative policy of the organisation. Regarding the management strategy following the emphases of living comfort (indoor and outdoor environment) and energy performance the final targets were obvious – to improve traditional procedures in retrofitting to ensure the targeted objectives.

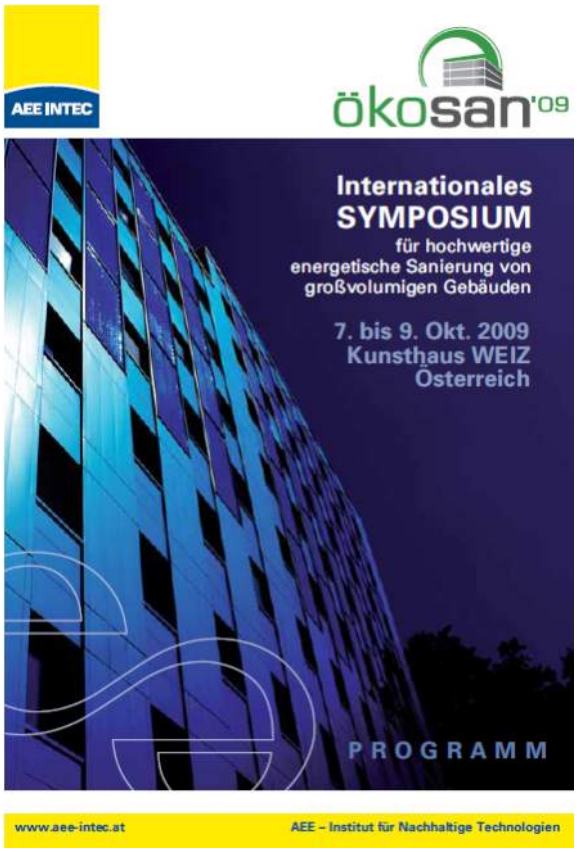
Experiences from the pilot projects of the SQUARE – partner countries applying the QA system were collected during the whole project duration. It was a strong intention of AEE INTEC to disseminated experiences among the national stakeholders (especially various housing associations, builders and umbrella organisations within the field of residential sector). Therefore a series of presentations were held to raise awareness:

Picture 17: "Strategieforum AEE INTEC" 18th Nov.09 – Presentation Armin Knotzer: "QA within building renovation" (Source: AEE INTEC)



Picture 18: "ökosan'09" 08th Oct.09 – Presentation Armin Knotzer: "SQUARE - QA within building

renovation" (Source: AEE INTEC)



Picture 19: "ökosan 09" – Technical tour 07th Oct. 09 to SQUARE pilot project Dieselweg (Source: AEE INTEC)

Planungswerkzeuge

Sitzungsleitung: Dipl.-Ing. Arne Kruft, EKG-Ing. Büro Kruft, München, Deutschland

10:45 Instrument zur Bewertung der Gebäudeenergieeffizienz in frühen Planungsphasen
Dipl.-Ing. Markus Gratzl-Michlmair, Insitut für Wärmetechnik, Technische Universität Graz, Graz, Österreich

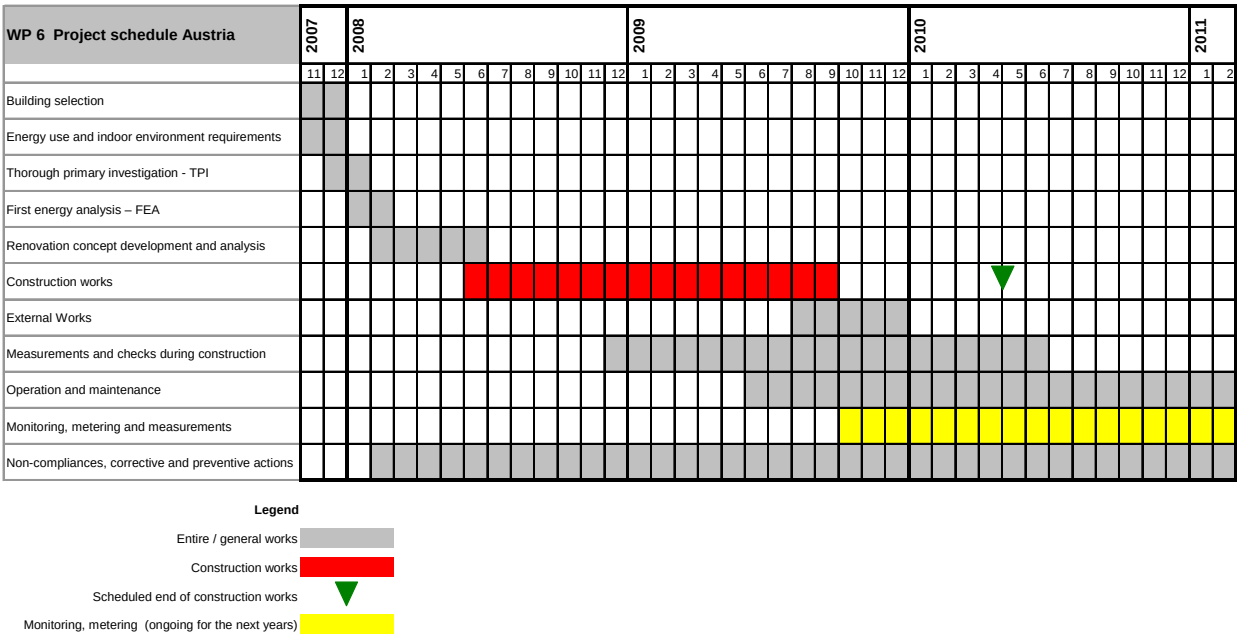
11:00 Wärmebrückenpauschale im Vergleich zur detaillierten Berechnung am ausgeführten Beispiel
Dipl.-Ing. (FH) Michael Mahler, Institut für ZukunftsEnergie-Systeme gGmbH (IZES), Saarbrücken, Deutschland

11:15 Qualitätssicherung in der Gebäudesanierung - Grundvoraussetzung für eine hochwertige Sanierung (Beispiele)
DI Armin Knotzer, AEE – Institut für Nachhaltige Technologien, Gleisdorf, Österreich

Picture 20: OTTI – Energetic renovation of buildings – Presentation Armin Knotzer on QA within building renovation (Source: AEE INTEC)

6 Final Project Schedule

The project timetable shows the steps from the planning to the construction and the monitoring. The green arrow marks the scheduled end of the construction works. One of the advantages of this renovation process is the very short time-span for the work on-site. Of course – the pilot-project "Dieselweg" as a pilot project needed a more intensive and detailed planning phase. The mounting of the first modules was very exciting – it was rather new process. But in the end it was possible to fasten the schedule. The work on-site could be finished in September 2009 (scheduled April 2010).



Picture 21: Project schedule (Source: GIWOG, depicted: AEE INTEC)

The yellow bar shows the ongoing monitoring and metering. The metering of consumption data started with the commissioning of the heating and ventilation system. But some temperature and humidity sensors within the apartments (on inner surfaces) were installed in February 2010. So the first data of an entire season (one year) will be available at the earliest in February 2011.

A Annex 1 – Technical Annex: Description of the Pilot Project

Residential area Dieselweg, Graz

Owner: GIWOG
Gemeinnützige Industrie Wohnungs AG
Architect: Architekturbüro
Hohensinn ZT GmbH
General Contractor: gap-solution GmbH
Energy concept: ESA-Energie Systeme
Aschauer GmbH
Report: AEE INTEC
Location: A-8041 Graz
Date: 2010

Key technologies
- Passive solar façade "climate wall concept"
- Heat supply with a high solar coverage + new kind of storage technology
- Heating- and hot water supply system between the façade and existing wall
- Decentralized ventilation system with heat recovery
- Controll and remote maintenance via internet
- Pre-fabrication of all facade components


[source: AEE INTEC]

The residential area Dieselweg comprises five single buildings and one long building row. One single building – Dieselweg No. 4 was chosen as representative for all others.

Background

Building before renovation:

- 16 Apartments
- Exterior walls, floor and roof without insulation
- Windows in need of rehabilitation
- Heat supply: 13% solid fuel, 33% oil, 54% electricity
- Power based hot water generation
- Low comfort
- High operating costs

Picture A1: View of building before renovation [source: GIWOG]

Picture A2: Site plan showing the entire area and location of building "Dieselweg 4" [source: Hohensinn ZT GmbH]

Building before renovation

Location	Dieselweg 4, Graz
Altitude	345 m
Heating degree days	3.499 Kd
Year of construction	1959
Number of apartments	16
Heated floor area	1.091,6 m²
Total heating energy (incl. hot water)	200.855 kWh/a
Spec. heating energy consumption	184 kWh/(m²a)
Installed heating capacity	71,83 kW
Spec. Heating capacity	65,8 W/m²

Figure 3: Typical floor plan of building [source: Hohensinn ZT GmbH]

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Renovation concept

Figure 4: View on renovated building [source: GIWOG]

The goals of the renovation strategy and the therefore used technologies were:

Goals:

- 91% reduction of the energy demand for heating
- Reduction of the costs for the hot water generation from ca. 0,40€/m² living area and month to ca. 0,10€/m² living area and month
- 89% reduction of the CO_2-emissions
- Increase of property value
- Improvement of the indoor environment quality

Technologies: see page 4

Design data for renovated building

Year of renovation	2008-2009
Number of apartments	16
Heated floor area	1589,4 m²
Total heating energy (incl. hot water)	15.258 kWh/a
Spec. heating energy consumption	9,6 kWh/(m²a)
Heating energy savings (174,4 kWh/m².a)	95 %
Installed heating capacity	11,13 kW
Spec. Heating capacity	7,0 W/m²
Current consumption (without heating)	34.031 kWh/a
Spec. current consumption	21,4 kWh/(m²a)

Figure A5: Pre-fabricated façade module with integrated window [source: AEE INTEC]

Figure 6: Floor plan changes of renovated building [source: Hohensinn ZT GmbH]

Renovation design details

Façade Solutions

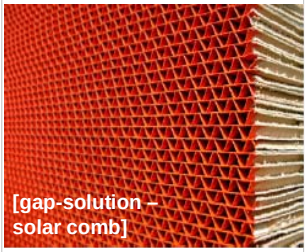

Figure A9: Façade insulation

• „To insulate with sunlight“
→ Special solarcomb construction (cellulose) converts light into heat (warm zone in the winter/ shading in the summer)
→ Rear-ventilated glass panels protect the solarcomb construction from weather and mechanical damage

• Increase of the surface temperature → improvement of the indoor environment quality

• High acoustical absorption

• Solarcomb construction can be painted in every color

Figure A10: Mounting procedure

Pre-fabricated modules:

• The joint formation is designed horizontally

• One joint at the level of the ceiling

• One joint on the upper line of the window

• Each module is matched on the lower one

Advantages of the renovation concept

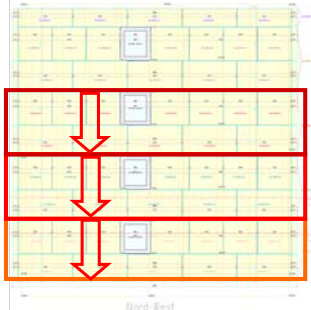

Figure A11: construction principle

• Energy performance = passive house standard

• Project management based on QA

• Improvement of indoor and outdoor environment

• Smart and quick construction procedure on-site

• Occupants are less disturbed during the construction phase

• The existing static system keeps unaffected

• Thermal bridges were eliminated determined by the system

• High quality because of the pre-fabrication in the fabrication hall

• Weather-independent fabrication

• Best quality assurance of produced modules in the fabrication hall

• Smart and short-time construction sites

• Dry mortar less construction

• Separable and particularly reusable components

Construction process

Development of pre- fabricated modules :

• 3D – on-site measurement of building façade

• Development of the pre-fabricated module by “gap – solution”

• Approval of the detailed composition of the modules by the building physician, consulted by AEE INTEC

• Design of each module and all detailed drawings (window-connections, plinth-weathering, angles,..)

• Approval of the detailed drawings, consulted by AEE INTEC

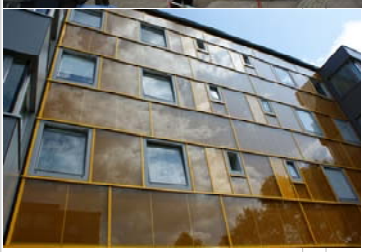

Figure A12-A15: mounting steps

Pre-fabrication on works :

• “Solar comb - system” pre-existing from “gap-solution”

• Fabrication hall of carpentry “KULMER BAU”

• Approval on works by building physician, architect, client

• The single modules are produced according to the on-site measurement and plans

Preparation before mounting :

• Installation of the elevator's construction

• Installation of electricity cables

• Bore – holes for ventilation – pipes

• Installation of heating supply for exterior walls

• Installation of equalization plane

• Mounting of sheet steel angles <bearing at the splint-weathering>

• Mounting of rock wool between post and mullion construction

• Mounting of vapour-proof barriers

• Cutting-off roof-overhang

Mounting and fitting the single modules :

• The pre-fabricated modules are brought by a truck and trailer on-site.

• Afterwards they are lifted by a truck-mounted crane to the building's façade.

• Two additional mobile-cranes are positioned on each side

• Assembly operators on these cranes are helping during the fitting procedure.

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Summary

At this showcase project (GIWOG) for the high-quality renovation of a large-volume residential building to a passive house, the heating costs could be noticeably reduced (ca. 90%). With the usage of alternative energy sources, e.g. solar modules, the CO_2 emissions could also be reduced. Thereby highest possible pre-fabricated and large-scale façade modules with integrated components for the building services were used. In this way an essential increase of the comfort and an improvement of the indoor environment quality could be achieved.

Figure 16-17: view of the renovated building

Practical Experience

Our reconstruction project in Graz, Dieselweg is remarkable for many reasons: All 204 flats were rented before and throughout all the construction time. The room heating was based on electricity, oil and coal. There were no elevators and a majority of senior inhabitants. The buildings were in a very poor condition according their age. Aiming a sustained, global technical solution – passive house standard, sustainable energy based heating, barrier free access, healthy room climate - we had to provide a perfect financial solution too, to convince the inhabitants to accept all the interference and disturbances. Supported by the Austrian system of public housing aid and additional aid of research funds and a special aid provided by the governor of environmental affairs of Styria, Manfred Wegscheider, in connection with the non-profit status of GIWOG we found a fit solution, in order to keep up the social low rental fees combined with a amortization of investments within reasonable time. We achieved affordable sustainability. The evaluation of the first results makes us confident, that we can keep our promises, given as well to our customers, as to the aiding institutions and our shareholders.

Georg Pilarz
(CEO) GIWOG AG

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