



Introduction

Three act2 projects in Hannover are described together: Energy efficiency in building (RUE) with 'Ecobuilding residential new build standard', 'Ecobuilding residential Kronsberg standard' and 'Connection to the district heating line from Biomass'.

This paper comprises the energy efficiency retrofitting of 254 apartments in 29 buildings dating from 1950 -1970 the housing associations Spar- and Bauverein eG and Gundlach & Co. Wohnungsunternehmen in two districts of Vahrenwald and Ahlem/Hannover. Retrofitting in this context means insulation of the building envelope and upgrading of the heating system to German new-build standard (EnEV 2004). By the end of 2007, modernisation of the 21 buildings located in Vahrenwald had been completed.

Implementation of retrofitting measures of the buildings in Ahlem has not yet started; it is planned for 2009/10. The preliminary concept and planning have been drawn up for eight buildings containing 72 apartments with a total area of 4,715 m².

'Kronsberg Standard' also aims at energy efficiency retrofitting of multiple occupancy residential buildings. The only difference is in the energy efficiency standard to be achieved; this 'Kronsberg Standard', devised in 1997 for the new-build Kronsberg district, is slightly more ambitious than the 'new build' standard. Within Concerto/act2, the City of Hannover wanted to prove that this standard for new buildings could be applied to existing buildings. Three buildings with 24 apartments in Vahrenwald owned by Gundlach Wohnungsunternehmen are part of this project. To achieve the 'Kronsberg Standard', some Passive House elements have to be incorporated. This project was also implemented in 2007.

Another Workpackage addresses the integration of biomass (wood pellets) as a fuel in an existing coal-fired CHP station providing the Vahrenwald district with district heating. All the abovementioned retrofitted buildings have been connected to the district heating system, and individual gas boilers have been replaced by a centralised heating system.

Encouraged by the success of the projects implemented so far, both promoters Spar & Bauverein eG and Gundlach Wohnungsunternehmen have decided to refurbish further buildings within the act2 programme.



'Ecobuilding: Retrofitting residential housing'	
Analysis	
Background	<p>About 2/3 of the housing stock in Germany was built after the Second World War. Most apartment blocks are in their original state except for some components such as windows that have been replaced. Modernisation of multi-occupancy housing to a high energy efficiency standard in order to reduce energy consumption and thus CO₂ emissions will be one of the challenging tasks in the near future. For Hannover, retrofitting is one of the measures to be applied within its 2008-2020 climate protection programme. The Concerto initiative helps by gathering experience of how to support an increase in energy efficiency modernisation and to cooperate with tenants.</p> <p>Two different standards for residential buildings will be applied within Hannover's Concerto/act2 programme:</p> <ol style="list-style-type: none">1. Ecobuilding residential to new-build standard, i.e. to German new-build standard EnEV2004 (254 apartments)2. Ecobuilding residential to Kronsberg Standard i.e. integration of more ambitious measures to reduce end energy use for heating to 55 kWh/m²/a (24 apartments) <p>The Kronsberg Standard includes Passive House components, namely triple glazed windows, minimising thermal bridges and installing mechanical ventilation with heat recovery.</p> <p>Gundlach Wohnungsunternehmen is a family-owned property company very committed to sustainable housing and building. Spar & Bau is a building cooperative. Both promoters are among the most important players in Hannover's housing market, managing 3,600 and 7,700 apartments respectively. They both have good reputations because of their business ethos as very open-minded promoters, ready to take new ways and test new technologies.</p>
Building Description	
Building type (number of flats, year of construction, floor area)	<p>The buildings, constructed in the nineteen-fifties and -sixties, are situated in the Vahrenwald district of Hannover. By the end of 2007, 24 buildings containing 202 apartments with a total floor area of approx. 12,000 m² had undergone extensive retrofitting.</p> <ul style="list-style-type: none">• Gundlach (10 buildings with 56 apartments (5,159 m² floor area)• Spar & Bau (14 buildings, 126 apartments (6,899 m² floor area).
Heating system	<ul style="list-style-type: none">• In all buildings the flats were previously heated by individual natural gas boilers (about 20 kW each). Within



	<p>the retrofitting programme the heating systems were centralised for each building and the building connected to the district heating system.</p> <ul style="list-style-type: none"> In 2006, this district heat was supplied from a large coal-fired CHP plant in nearby Stöcken. Within the act2 programme the plant has been partially converted to renewable energy sources; wood biomass instead of coal will meet the final energy demand (1,100 MWh) for heating the ecobuildings during the Concerto project period.
Project Description	
<p>Aims</p>	<ul style="list-style-type: none"> Reduce annual end energy use for heating by more than 2,000 MWh by retrofitting the building envelope. CO₂ emission savings of up to 380 t/a or 58% have been calculated. Increase comfort level for tenants; surface temperature of exterior walls is higher than before. Save on annual primary energy use by nearly 3,000 MWh, corresponding to a reduction in CO₂ emissions of 500 t, through connection to the biomass-fuelled district heating system. Critical spots / areas of extensive moisture damage should no longer exist. Because of the airtightness after modernisation the comfort level improves. Reduce tenants' energy costs Increase the value and rentability of the apartments.
<p>Key points</p>	<ul style="list-style-type: none"> Along with the overall refurbishment planning, an additional concept for energy efficiency with an economic viability analysis was needed in order to exploit all the potential such as energy savings and financial gain. Tenants did not move out for the refurbishment period, and the construction supervisors paid particular attention to scheduling work to minimise nuisance for tenants. To ensure the quality of the work and introduce the innovative techniques, training sessions for craft workers were held on site. Throughout the construction period a five-stage quality assurance process was carried out: <ul style="list-style-type: none"> Stage 1: Checking adherence to the required transmission heat load and resultant yearly space heating demand Stage 2: Checking detailed planning Stage 3: Checking work on site and documentation Stage 4: Measuring adherence to limit values for airtightness Stage 5: Certification
<p>Measures implemented</p>	<p>In all buildings the whole envelope has been insulated. The following list gives an overview of the average thickness of the insulation of the different components:</p>



	<ul style="list-style-type: none"> • Insulation of exterior walls: 16 cm • Insulation of ceilings: 20 cm • Insulation of cellar floors: 6 cm • Windows upgrading with heat absorbing glazing to $U_g = 1,1 \text{ W/m}^2\text{K}$ • Connection to the district heating system instead of individual apartment gas heaters • Improvements to airtightness • Modernisation of bathrooms
Monitoring and evaluation	<p>Monitoring started in 2006. The first findings from the heating periods 2007/8 and some of 2006/2007 can be presented for 24 buildings totalling apartments flats or almost 12,000 m² floor area.</p> <p>Energy savings achieved by the retrofitting measures are significantly higher than in conventional refurbishments, both as regards savings in percentage terms (50-70%) and the specific energy consumption for heating and DHW (68-111 kWh/m²/a). Experience from other refurbishments show that the energy consumption will probably decrease in subsequent years if tenants get used to the better energy standards and adapt accordingly.</p> <p>A comparison between the buildings of the two housing associations shows that the slightly more ambitious measures in the Gundlach WU buildings (e.g. minimisation of thermal bridges, new windows instead of only changing the glazing) led to a lower specific heating energy consumption. In all these buildings, the Kronsberg Standard has been met.</p> <p>Comparison of the metered results with theoretical calculations shows that the predicted heating energy savings as percentage have nearly been achieved in practice; in two cases they have even been slightly bettered.</p> <p>Because of the minimisation of heating energy consumption, the energy use for DHW preparation and distribution losses rises as a percentage. As a result, the relevance of these aspects becomes greater after ambitious energetic retrofitting concerning the optimisation potential of further measures as well as the possible accuracy of monitoring.</p> <p>So far only heating energy demand within the buildings has been analysed. Calculation of primary energy savings and CO₂ reductions achieved through partial conversion of the district heating system to biomass and the electricity consumption in the apartments will follow in the spring of 2010.</p>
Costs & Benefits	
Costs & funding	<p>The investment costs of the construction projects implemented so far amount to 3,9 million €, divided as follows:</p> <ul style="list-style-type: none"> • Building insulation: 2 million € (50%) • Conversion of the heating system: 1 million € (25%)




	<ul style="list-style-type: none"> • Planning: 758,000 € (20%) • Quality assurance: 117,400 € (3%) <p>Broken down per m² the specific costs are on average as follows:</p> <ul style="list-style-type: none"> • Insulation and heating system: 250 €/m² • Planning 63 €/m² • Quality assurance: 10 €/m² <p>There is certainly potential for reducing planning costs, which have been markedly high due to the requirements of the different funding programmes.</p> <p>The retrofitting projects have been financed by the promoters, who received total funding of about 875,000 €, sourced as follows:</p> <ul style="list-style-type: none"> • 472,000 € from the Kreditanstalt für Wiederaufbau (national bank) (54 %) • 228,000 € from proKlima (26 %) • 175,000 € from Concerto (20 %) <p>Concerto funding could be used as an incentive to achieve higher retrofitting standards than those required by statute.</p> <p>The requirement on the building envelope to meet new-build energy efficiency standards was tied to an incentive to pull down funding from the Kreditanstalt für Wiederaufbau (national bank managing federal funding programmes). This national funding comprised a low-interest loan and partial debt remission.</p> <p>The Hannover-specific proKlima fund complemented the funding concept with support for the inclusion of highly energy efficient construction components and corresponding advice and quality assurance monitoring.</p>
Benefits	<p>This refurbishment of multi-occupancy housing has produced a multiple-win situation:</p> <p>Housing Associations</p> <ul style="list-style-type: none"> • Higher rent income • Added property value, apartments easier to rent out • Better public image <p>Tenants</p> <ul style="list-style-type: none"> • Significant reductions in energy costs • Less vulnerable to energy price rises • Modernised apartments • Enhanced general appreciation of 'their' buildings <p>City of Hannover</p> <ul style="list-style-type: none"> • Upgrading of residential areas and their neighbourhoods • Successfully implemented components of the municipal climate protection action plan • Stimulation of the local economy



	<p>Craftsmen</p> <ul style="list-style-type: none"> • Know-how gain • Better image
Partnership details	
Partners and role	<ul style="list-style-type: none"> • Spar & Bau, Gundlach WU: housing associations • GMW consulting engineers: Project management, tenant support, construction management • target GmbH: training for craftsmen • Kommunikation für Mensch und Umwelt: tenant survey and socio-economic questionnaires • proKlima: monitoring and comfort level measurement in cooperation with E4-Consult, Hannover and the Passiv Haus Institut, Darmstadt
Recommendations	
Barriers to overcome	<p>Tenants:</p> <ul style="list-style-type: none"> • Negative attitude to refurbishment activities (e.g. reduced energy bill doesn't always compensate for higher rent) • Objections against replacing individual apartment heaters by a centralised heating systems; no direct control over the system • Modernisation work while they are living in the apartments • Lack of knowledge on how to use the new technology <p>Promoter:</p> <ul style="list-style-type: none"> • Business as usual is much easier than being a pioneer (installation of innovative technologies, obligations for participation in a work-intensive monitoring programme, reporting and quality assurance). • Economical liability of certain measures e.g. mechanical ventilation • Extra time needed for communication and interaction with other players <p>Political/legal:</p> <ul style="list-style-type: none"> • No rigorous enforcement and lack of political will • Insulation infringes property lines, and special permits had to be granted by the City building regulations department.
Lessons learned	<p>Both promoters were very well aware that acceptance of the refurbishment measures by tenants was crucial to for the success of the projects. Therefore tenant information on the refurbishment activities was given at an early stage, especially regarding changes to rents, energy costs and additional costs to be met by the tenants. During the refurbishment period, a tenant support service was on hand that provided initial information and support/liaison while work was going on.</p> <p>Experience gained in another pioneer project, called 'factor 10' and funded by the German Environment Foundation DBU (Costs were excessively high and the tenants disabled the system), led</p>



	<p>Gundlach WU not to install a mechanical ventilation system with heat recovery as initially planned. . However, evaluation of the monitoring programme might show that on construction physics grounds a mechanical ventilation system might be mandatory.</p> <p>All the available local, national and international funding instruments must be included in such an ambitious retrofitting programme; without them (and they certainly have potential for expansion) this type of building refurbishment and resultant energy saving effect would not have been possible. Concerto funding represents just a small proportion of the total incentives; it was only attractive in combination with other funding instruments.</p> <p>The City of Hannover insisted on promoters' participation in the quality assurance programme. This programme was introduced very successfully for the Kronsberg district. The tool has been adapted for building rehabilitation and has proved its usefulness. The quality assurance monitoring has been carried out in order to:</p> <ul style="list-style-type: none"> • ensure that building envelopes meet the Concerto specification • minimise thermal bridges and ensure airtightness of structures, to avert heat loss and structural damage due to poor workmanship • check that work meets the specifications required by plans and working drawings • guarantee the quality of work for property owners and tenants.
Pictures	
	 
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