

Hannover Kronsberg Handbook

Planning and Realisation

City of

Hannover

The Lord Mayor
Directorate of Environmental Services
Directorate of Construction and Planning

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FOREWORD

In developing the Kronsberg City District, the City of Hannover realised one of its most pressing aims: to solve the serious housing shortage of the 1990s and concurrently, in the context of the EXPO 2000 World Exposition, to present a comprehensive example of visionary urban planning and construction. The overwhelmingly positive response of professionals at home and abroad to the Kronsberg District confirms the success of this project.

Now the district, comprising 3,000 dwellings, is home to around 6,600 people, with almost 3,000 jobs located in the immediate vicinity. The time is ripe to take stock of the planning process and the experience gathered through it.

In designing and creating this new city district, all available knowledge of ecological optimisation in construction and habitation, along with urban planning and social aspects was applied – consistently, holistically and throughout the area according to the principles of Agenda 21. The result today is a settlement with exceptionally high ecological standards, buildings offering above-average quality of accommodation and semi-natural open space design across the entire residential area. The district thus represents one of the largest and most visionary settlement programmes of its kind in Europe.

From a very early stage Hannover City Council committed itself to implementing selected projects for EXPO 2000 according to the World Exposition's motto, 'Humankind – Nature – Technology'. Kronsberg with its ecological optimisation undertakings constitutes an important focus of these decentral EXPO projects; the district itself became an exhibit. Demands for quality and the tight schedule through to EXPO 2000 set those responsible a particularly difficult challenge. Only through a differentiated planning procedure and setting binding quality standards for all planning measures could the idea of sustainability be broadly applied.

In this handbook, the special planning procedure applied at Kronsberg is presented in detail. The thematic focus is on explanation of the various planning instruments used to implement the very ambitious planning aims. Implementation of these instruments has been fully justified, as demonstrated by the high quality of life in the district today. From the experience gathered on Kronsberg, this planning procedure is transferable to other development projects, not only in Germany but also across Europe. In this sense the handbook can provide support and advice for future planning initiatives.

Our thanks are also due to the many employees of Hannover City Council and other institutions, whose energy and commitment have made this handbook possible.



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HANNOVER KRONSBURG HANDBOOK

Planning and Realisation

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INTRODUCTION



Kronsberg c. 2000 BC, New Stone Age: original landscape with the first settlements



Kronsberg c. 1300 AD, Medieval: small farms and hamlets in clearings



Kronsberg c. 1980: late 20th-century industrial agriculture with settlement margins and the village of Wülferode



Kronsberg c. 2050: vision of sustainable landscape and residential development

Advice on using the Handbook

This work is called 'Handbook Hannover Kronsberg'. It describes the district in its entirety and its significant elements that are important for implementing the new vision of sustainable development. To this extent it cannot be considered a handbook in the conventional sense, where the current state of technical development and research is processed from a cornucopia of experience and generally-recognised knowledge into a concise and clearly arranged form. Nevertheless, the handbook form was chosen to offer various interest groups a brief, concise overview of the entire undertaking and concurrently to present information on the separate areas. While previous publications have been concerned with presenting the Kronsberg concepts, in this handbook the attempt is made to describe ways in which the vision of sustainable development was put into practice throughout the ten years of the planning and construction process.

The Handbook is intended for those who are planning or wish to begin comparable urban development projects, who have political responsibilities at local authority level and who, through their decisions, will create the framework conditions for such projects. It is addressed to town planners and architects who, with their designs for the townscape and ideas for single buildings, create the foundation for applying the vision of sustainable urban devel-



View towards the city centre

opment. It is also written for property investors and developers who need convincing that it is commercially viable to build housing within a framework of sustainable urban development. It is also intended for specialist practitioners in the various urban construction, landscape design and technical infrastructure professions, who ensure that the objectives are achieved in the form of meeting technical standards and setting more ambitious quality benchmarks.

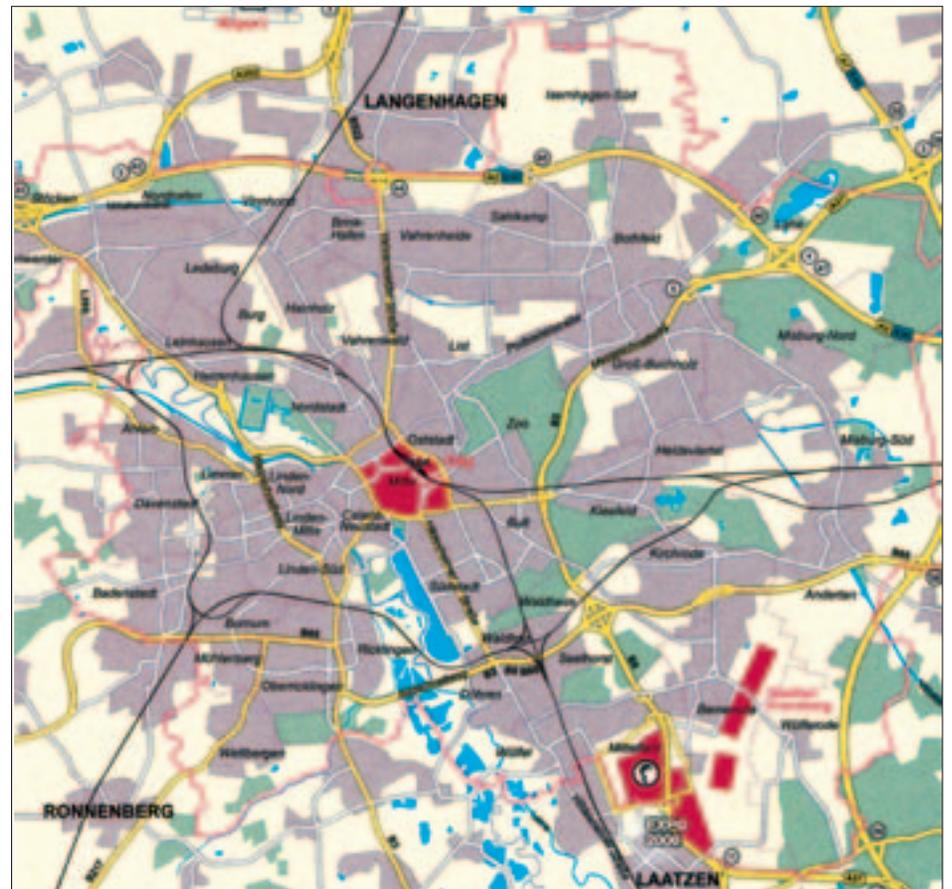
The Handbook is conceived as a vade mecum for praxis, applying the standards achieved at Kronsberg in other comparable projects. Transferability for urban development practitioners will be no problem in Germany. Direct transferability across Europe will, however, have limitations imposed by variations in the framework conditions created by national legislation but also by climatic differences. Experience with other transnational projects such as ‘exocities’ (Energy Extensive Planning For Cities), in which Hannover participated along with Utrecht, Lisbon and Palma de Mallorca, has shown that transnational knowledge transfer is useful and possible because examples and approaches to solutions can be applied following the spirit of the original and adapted to local conditions.

What is, however, so special about the Kronsberg Project? At first glance a visitor will see no essential differences from other modern residential areas. Only when the energy efficiency standards applied here, which have made it possible to reduce con-

sumption by more than half in all the Kronsberg buildings, are appreciated does the difference from conventional planning become clear – and energy is just one of around 15 aspects of the urban planning concept.

The completely newly defined and conceived planning for the district of Kronsberg was derived from a new vision oriented on sustainable development as posited by Agenda 21. Implementation demanded not only new procedures but also the definition of new standards and quality determinants in almost every area covered by conventional urban planning. In the light of the many stakeholders in the planning and construction of a new city district, the initial priority was to convey the vision, the new stand-

The World Exposition / Hannover Trade Fair grounds and the Kronsberg development



ards and quality benchmarks for each area of activity. After that, the planning and construction process had to be guided and coordinated over a ten-year period and new instruments were devised for this.

Why should the results and findings from the Kronsberg project be passed on to others? The project is one of perhaps half a dozen in Europe that have addressed the sustainable development vision. This is not concerned with a list of objectives but with a crucial new vision that was declared as binding on almost every level of action at the 1992 UN Earth Summit in Rio de Janeiro. Sustainable development is the guiding principle of Agenda 21, the most important document to emerge from the Rio conference and signed by heads of government throughout the world.

In order to understand the Handbook it is helpful to call to mind the significance and the central statements of the Agenda 21, an action programme for the development of the world through the 21st century. It is based on the scientifically supported recognition that the natural resources of our planet are limited and that, in the light of both rising world population and uncontrolled consumption of resources particularly by the industrialised countries, they are running out fast. Starting from considerations of a more just distribution of these reserves, Agenda 21 shows chapter by chapter how a more careful and just treatment of these resources is achievable.

In this area, Agenda 21 is addressed particularly to the industrialised countries and calls on them to make their contribution to sustainable global development. This challenge has been taken up in different ways by the industrialised countries since the Rio summit. While, for instance, The Netherlands in the work, 'Sustainable Netherlands', have shown the consequences of applying Agenda 21, and Denmark has markedly reduced consumption of fossil fuels through developing wind power, other countries have done little for sustainable development in the ten years since Rio.

The European Union declared sustainable development to be a guiding principle of its policy at an early stage. It is to be found today as one of the fundamental EU principles in almost every action programme and statement of aims.

To summarise, it can be seen that Agenda 21 has initiated a paradigm change in planning at almost level of action. At the 2002 UN conference in Johannesburg in 2002, which was seen as the successor to Rio, countries aimed to take stock after ten years of Agenda 21 and develop the guiding principles further.

In practice it has also been apparent that the new vision of sustainable or durable development is, because of its local and global dimension, not that easy to understand or to apply. This is particularly true of the local level of cities and local authorities, where political and administrative bodies are focused primarily on shaping the present and immediate future. Here, 'on the ground', is the meeting place of two barely compatible value systems – coping pragmatically with everyday problems collides with realising a demanding new vision. This is true to an exceptional degree of urban planning, previously charged with solving immediate problems such as housing shortages, industrial settlement and urban expansion driven by economic growth.

The concepts for and solutions to single components of town planning as presented in the Handbook are derived in their essentials from the guiding principles of sustainable development, and if these objectives are not accepted the individual solutions will appear arbitrary and interchangeable.

Hannover City Council had prepared the ground for acceptance of the new vision in the city back in 1990 with its resolution to create the infrastructure for EXPO 2000. The World Exposition was to embody the motto, 'Humankind – Nature – Technology', encapsulating the entire theme which was to find formal expression as Agenda 21 two years later at the Rio conference. All plans and projects that emerged in the context of the World Exposition were, by order of the City Council, to be undertaken according to the same principles as the EXPO itself – and this included, of course, the new Kronsberg district.

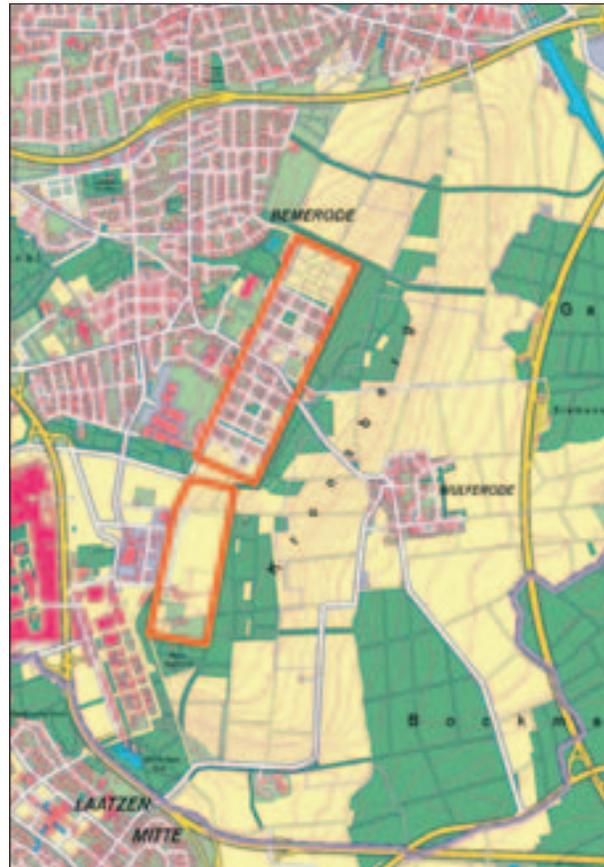
The Handbook presents more than 12 years of work on the planning and construction of the Kronsberg district, from the greenfield site to the opening of the community centre. It shows a many-layered process from the empowering City Council resolution in 1990 through to the completion of around 3,000 homes.

To clarify this complex process in which the most varied stakeholders were involved, it is divided here into two planning and construction phases that, in reality, could not be clearly distinguished. The first phase covers the period of the political decision and every stage of preparatory development planning along with the environmental and transport investigations that preceded and informed the planning and construction work. At an early stage, too, assessments of the shops and services concept and environmental impact analyses were completed. Before the statutory planning procedures were started the City of Hannover as the body with overall planning responsibility staged a series of planning competitions. They covered the overall concept for the district in the spirit of the new aims of sustainable development and concepts for the main areas of the local authority's remit such as landscape, town planning, housing construction, traffic, green-space, social and cultural infrastructure, energy, water and waste. The first phase was concerned mainly with the single components of planning and preparation for the construction measures.

The second phase covers the implementation of the overall concept in all its components. This happened mainly in the individual construction projects and the detail planning they required. Here, the single elements of construction planning are sectioned according to the responsible planning department.

The presentation focuses point by point on those aspects of the planning and realisation process that were significant for creating the district in the spirit of sustainable development. These consist partly of conventional procedures that were, however, extended to cover sustainability aspects. In some cases new procedures for the planning, implementation and monitoring were also devised to apply the special standards and quality norms.

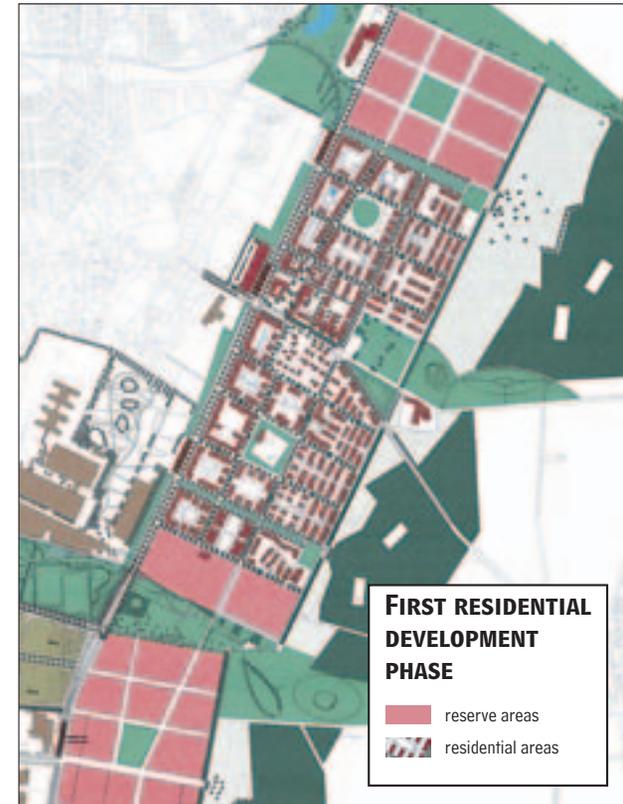
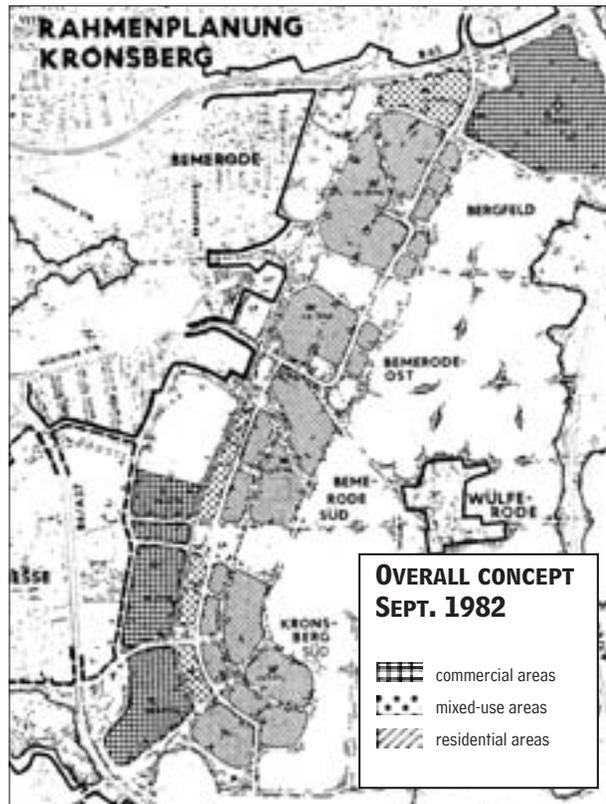
For both phases, the integrated or networked planning procedure is presented, in which many stakeholders were involved throughout the entire decision-making, planning and implementation process – every urban construction professional will know the inherent problems posed by the various interests to be coordinated if the overall objectives are to be met. And it is only when the interplay of the components is coordinated over the long timescale of a project that the aims of the original empowering resolution can be achieved. This has been achieved at Kronsberg for a wide range of components of the new vision.



Kronsberg planning area

SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

1. Fundamentals



1.1 URBAN PLANNING AND CONSTRUCTION

Overall Concept

As long ago as the 1950s – starting with the question of how Hannover could develop – various planning concepts were drawn up for Kronsberg which, in the form of the 1st ‘Rahmenplanung Kronsberg’ in the early 1980s resolved into a conclusion. This was essentially characterised by the following components:

- A commercial ribbon development on the southwestern edge of Kronsberg hill, related to the trade fair grounds (‘Gewerbepark am Messegelände’)
- Residential ribbon development on northwestern Kronsberg, from the B 65 national highway to Wülferoder Weg
- Landscape care measures on the eastern and northern parts of Kronsberg.

The prerequisite for this framework concept was the transference of the entire Kronsberg area (and that of the trade fair grounds) to the City of Hannover’s planning jurisdiction as part of local government reform and redefining of boundaries in 1974. It followed the regional planning principle, according to which residential development should in the main expand along local rail public transport routes and be concentrated at urban densities in the catchment areas of the stops and stations.

The EXPO 2000 World Exposition was the occasion to apply this planning approach to the Kronsberg area. On the basis of two planning competitions and with the help of the Kronsberg landscape plan, a concept was devised for the entire area that covered the EXPO grounds, the new settlement and the countryside. The legislative basis for its realisation was the 49th amendment to the land use plan as approved by the City Council in 1994.



View of the northern neighbourhood park

The new district runs roughly north-south along the western slope of Kronsberg hill beside the new tramline, thus linking the older district of Bemerode with the World Exposition grounds. Its eastern boundary to the countryside is defined for several kilometres by an avenue. The dispersed development in Bemerode to the west is contrasted with the rectilinear blocks of the Kronsberg development. The new district is laid out across the contour, in neighbourhoods with their own distinct identity, each of them grouped around a neighbourhood park and bordered by park corridors or green zones along the streets.

In what follows, the crucial elements of implementing the sustainable urban development vision will be briefly presented.

Compact Structures and High Building Density

The appearance of the district is shaped by its wide-meshed rectangular grid layout, which creates frames for very varied block structures. Low land take by means of high-density construction was the primary planning aim. The built-up, urban quality of the townscape is the result of design parameters that set the number of storeys, building heights and building lines along the streets. Along with the demand for compact structures, an important condition was that all corner plots should be built on.

The development structure follows the principle of decreasing density and building height as one approaches the countryside. The highest densities, with a floor space index of 1.2, were achieved in the

relatively compact four- to five-storey blocks along the main access road at the bottom of the hill. As one approaches the hilltop the development becomes looser, with three-storey blocks and pavilion structures giving way to a terraced house development beside the border avenue. The dimensions of the development plots (1.2 hectares, and 1.8 hectares on the uphill side) are relatively large, and the proportion of public access space (19% of the 70-hectare site) is thus comparatively low.

Varied Architecture and Accommodation

The grid layout of the blocks, the avenue-like streets and the open space planning unite many different construction forms and architectural styles in a harmonious townscape. Over 40 architectural and open space planning offices applied very different approaches and design solutions, in many cases after design competitions.



SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

1. Fundamentals



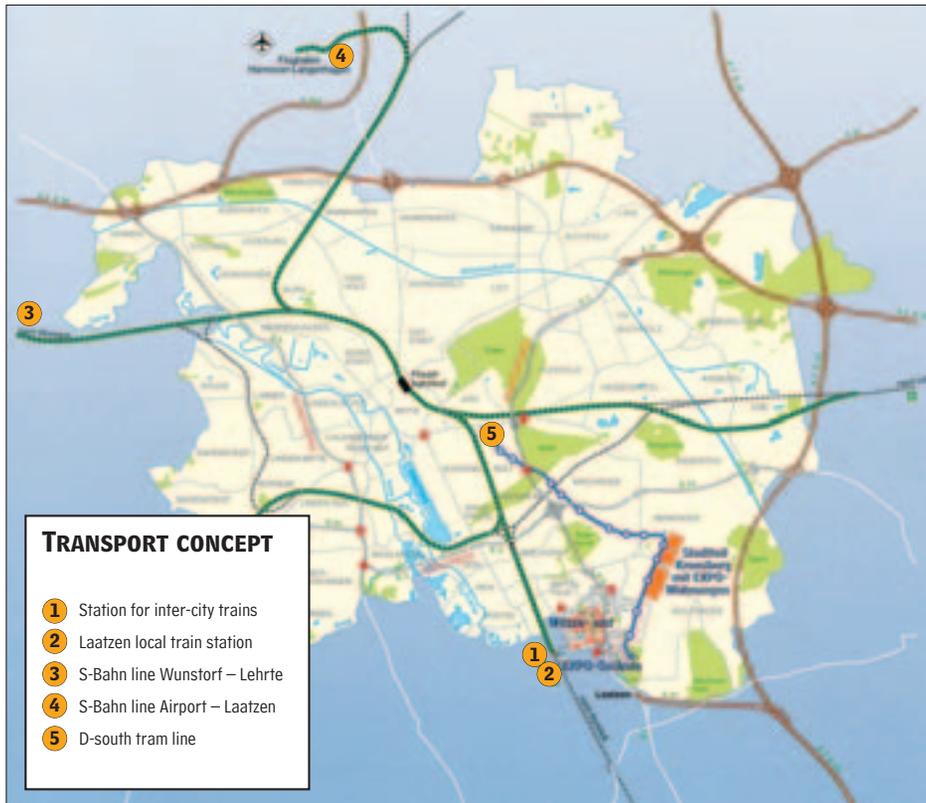
Most of the buildings are aligned to the contours of Kronsberg hill, which makes the best use of natural light from the east and west. Many buildings have stepped storeys with gently sloping single-pitch roofs, often combined with rooftop terraces. Façades are typically of light-coloured rendering or red brick.

A wide range of good-value apartments is the defining characteristic of the accommodation. Apartments are designed to be light, airy, space saving and well fitted. The range of accommodation includes penthouse apartments with well-proportioned terraces, maisonette apartments and ground-floor apartments with tenants' gardens.

Environmentally Sound Transport Concept

Environmental compatibility and the compact community were the paramount aims of transport planning for the Kronsberg district. A new direct tram service links the settlement with the city centre. Three tramstops are so located that nobody has to walk more than 600 metres to catch a tram.

The main motorised traffic flow is channelled along the edge of the development beside the tramline to minimise nuisance to residents. Planning of the residential street layout permits no through traffic. Narrow sections on the roads, 30 kph zones, and priority to the right at junctions, are effective traffic calming measures. Car parking spaces are mainly arranged in small areas, either set into the hill-



Kronsberg tramstop

Private parking spaces



side or at ground level. Around a third of car parking is underground. To reduce the parking space needs in the inner courts, a parking space ratio of 0.8 per apartment was set at Kronsberg. This was compensated for by a 0.2 increase in the ratio for parking spaces on the public streets, which means that they are better used over the day, and the area needed for motorised access in built-up areas is reduced.

A cycle-friendly street layout with a designated cycle street running the length of the district offers, together with a dense network of rural and urban footpaths, an attractive alternative to private motorised transport.

Complex Use Profile and Infrastructure

The new residential area on Kronsberg, the adjacent commercial areas with their numerous new service industry jobs, and the neighbouring countryside create an urban spatial unity. Currently around 6,300 people live on Kronsberg in the first two development

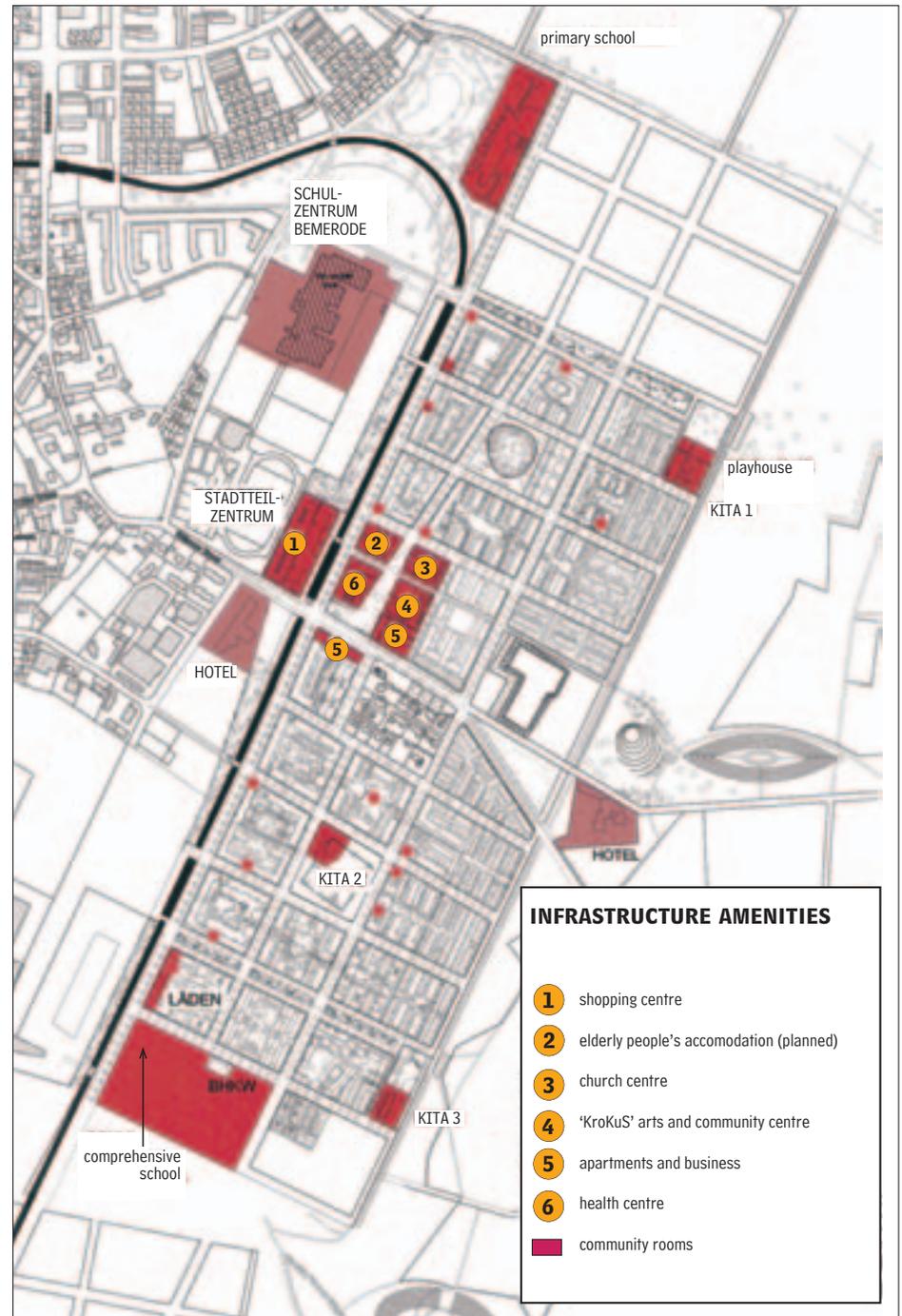
LBS office building



Primary school



dvg office building



SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

1. Fundamentals



Farmers market

Children's day centre 2



'KroKus' arts and community centre, and the church centre

phases, Kronsberg-Nord and Kronsberg-Mitte. The Kronsberg-Süd (South) phase and further building land to the south are reserved for later development. Concurrently with housing construction in the first phase, three kindergartens, a primary school with an after-school centre and sports hall, a play house and around 15 community rooms were built.

Along the tramline and the main access road, an attractive location for shops and offices has developed. At the mid-point of the present settlement these uses are concentrated with a shopping centre, a district square, the 'KroKus' arts and community centre, a health centre and a church.

Across the main road, around 3,000 office jobs have located at Kronsberg in the new buildings of the LBS and dvg banking and data processing companies. To these can be added in the immediate vicinity 700 jobs at IBM, employment at the Deutsche Messe AG trade fair company and new commercial uses for the Expo grounds on the Plaza and the Eastern Pavilions Area.

Balanced Residential Profile and Social Infrastructure

It is intended that in each development block, the wider aim of a broad social mix for the district should be applied on a small scale. When applied to the individual construction projects, this meant that grants and subsidies were used as incentives to provide a mixture of types and sizes of accommodation. As was expected, property developers applied for subsidies in diverse forms, thus ensuring the desired social diversity. Although subsidies were available for the entire district, to avoid a social imbalance in the population devel-



One type of terraced house

opers took up the municipality's offer to transfer its option on around 500 social housing apartments to other parts of the city. For all the rest, the municipality renounced its right to allot housing seekers for the first tenancies. Additionally, the upper income limit for social housing eligibility was doubled for the first occupation phase.

The development plan foresaw around 200 owner-occupier terraced houses, about 10% of all dwellings. Most of these houses were erected early in the construction phase to create a positive image for the district and generally to stabilise its social structure. To make it easier for young families to settle on Kronsberg, developers were set an upper price limit of 163,361 Euro. Every buyer who had signed the contract by 1997 also received a discount on the price of the building plot.

The district is not only exceptional in its mixture of social classes but also in the way it integrates elderly and/or disabled people and various ethnic minorities. The 'FOKUS' housing project's decentralised care system makes it possible for elderly and disabled people to live self-sufficiently in their own adapted apartments. The 'Habitat' housing project is intended to help German and foreign residents to live in harmony, in that its design and construction take account of the needs of different cultures and religions.

Socially Compatible District Development

Urban development at Kronsberg was preceded by interdisciplinary dialogue between specialists in the City's Construction and Social Services directorates, the results of which were fed into a catalogue of social planning needs to be addressed by the urban development projects.

Among the central requests were flexible accommodation to cope with changing housing needs, a mixture of large and small apartments, and apartments suitable for families and for new lifestyles. The objective was to avoid social segregation by mixing various forms of housing finance and ownership and limiting the proportion of apartments on which the municipality had an option to place socially or financially disadvantaged tenants. Arranging small, legible housing blocks around a green inner court aimed to encourage the development of neighbourhoods. Infrastructure support for community development included both traditional amenities such as kindergartens and schools and also communication and neighbourhood facilities across the usual client groups, such as rooms close to the apartments that could be used for many different social, cultural and communal purposes. Development of the social and cultural infrastructure parallel to the housing construction was seen as crucially important.

*Communal use room:
the 'earth house'*



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SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

1. Fundamentals



1.2 OPEN SPACE PLANNING AND IMPLEMENTATION

Overall Concept

In Germany, applying the new vision especially addresses the provision of public and private greenspace close to home. The proportion of open space in the Kronsberg district was raised by 5–10% compared to conventional urban planning.

The shaping elements of open space in the district – five transverse green corridors and the hilltop woodland parallel to the development – create the most important primary links with the adjacent countryside. A differentiated system of interconnected public, semi-public and private areas close to the homes offers numerous and differing green- and open spaces. Both in the private and the public spaces, the necessary rainwater retention and infiltration areas are diversely integrated in the designs.

The Kronsberg Countryside

The eastern edge of the development is defined by a double row of trees lining the border avenue. Beyond them is the Common, used for several purposes – open grassland cared for through extensive mowing or grazing. Where the green corridors come up to the crest of the hill, the Common is landscaped with viewpoint hills and copses of trees offering spaces for play and exercise. Children's playgrounds set into the residential area at these locations create close connections between settlement and countryside.

Recreational space close to home is provided especially by the new woodland planting on the crest of Kronsberg hill, a transitional area between the leisure space near the settlement and farmland on the eastern hillside. The clearings in the wood, while all the same size, have been landscaped with open greensward, play- and exercise structures and subdivisions with hedges, and so each of them has its own distinctive character.

Viewpoint



Border avenue



Hillside Park Corridors and Green Streetscapes

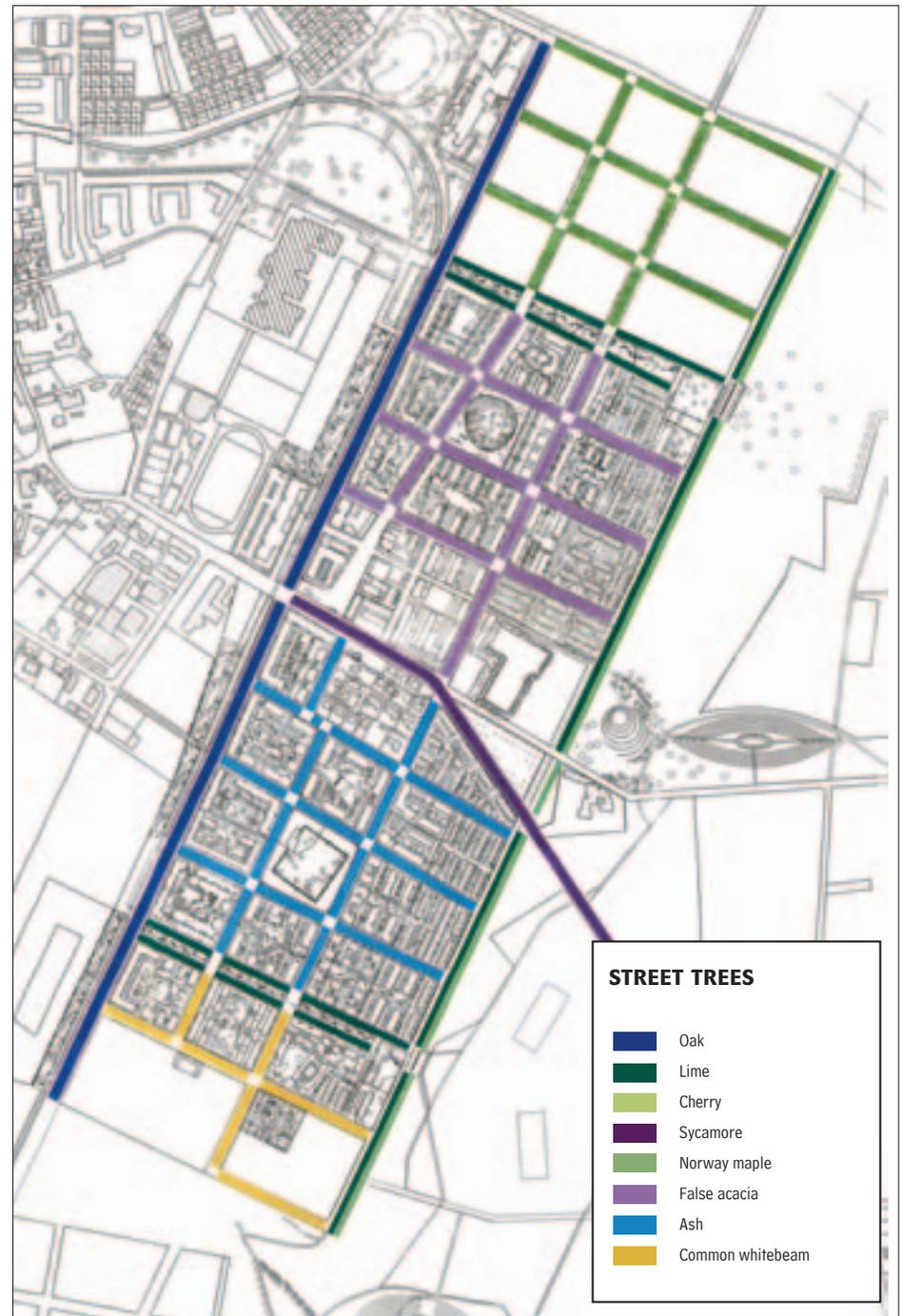
The green spaces between sections of the district were created as park corridors to connect the residential areas with the hilltop woodland and to continue into the countryside. These park corridors have thus both a dividing and a linking function, defining neighbourhoods and tying the countryside into the built-up area. They are distinctively landscaped, offering various ways of using them and designed in clear contrast with the surrounding countryside. There are breaks in the hilltop woodland where it intersects with the park corridors, dividing it into sections. At the top of each park corridor is a viewpoint plateau from where one can see back over the city and out into the countryside.

In the rectangular layout of the district, trees define the streetscape. All streets are laid out as avenues, and a different variety of tree in each neighbourhood contributes to its particular character. Soakaway hollows and gravel-filled trenches to infiltrate rainwater runoff are integrated in the grass verges. The transition to built areas is marked with front gardens. The sylvan character of the streetscape makes them both pleasant places to linger and important links in the open space network.

Neighbourhood Parks

The location and distribution of the neighbourhood parks make a strong contribution to the legibility and design quality of the district. They are on the longitudinal centreline of the district, bordered by eight blocks constituting a neighbourhood. Their prox-

Example of street greenery



SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

1. Fundamentals



imity to the homes makes them convenient for play and leisure, and so the master plan designated them as public playgrounds, although they also have secluded areas for quiet relaxation. The streets around the parks are included in the overall concept as places to meet and linger.

The parks make a strong contribution to the identity of their neighbourhoods, and therefore their planning took into account

more than the many demands made on their use. Each neighbourhood park's striking design gives it an unmistakable appearance and offers spaces for various activities. One of the parks so far constructed incorporates a children's day centre. Designs for the parks were selected from competition entries to the 'Realisierungswettbewerb Quartierparks Stadtteil Kronsberg'.

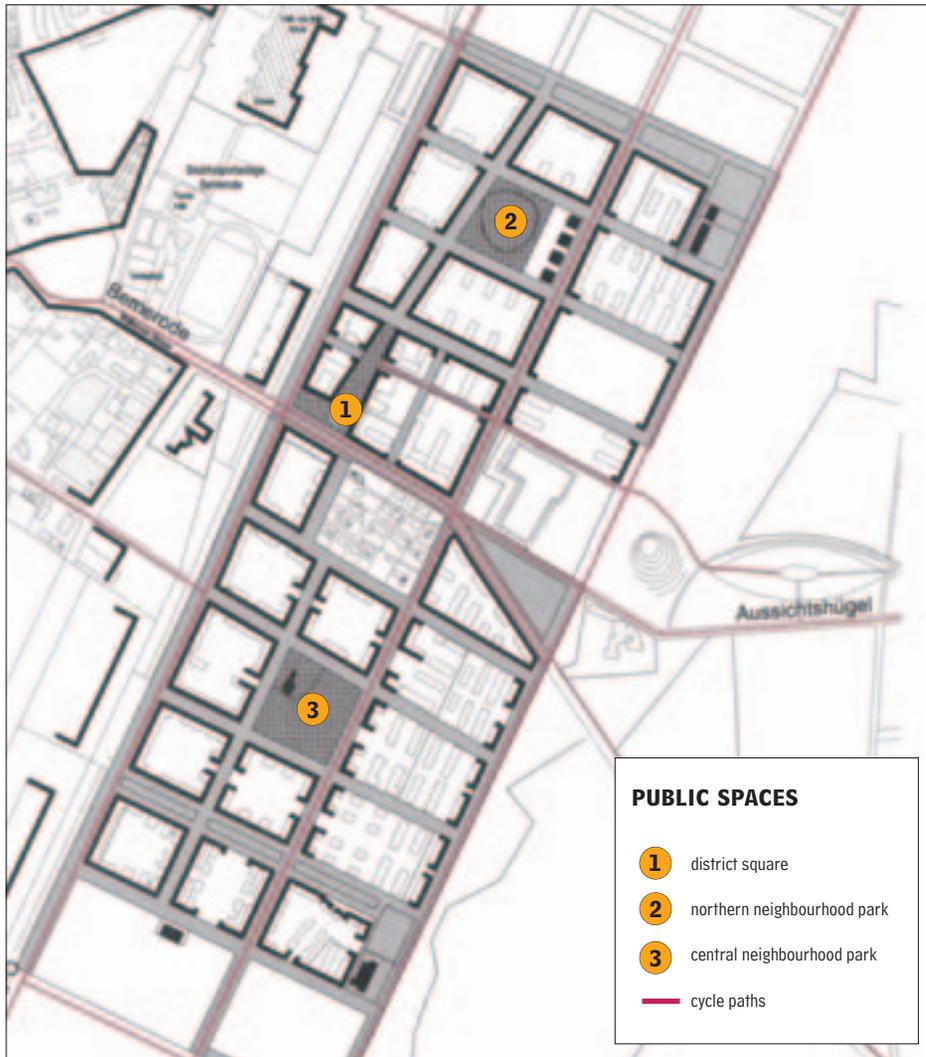
Communal Inner Courts and Private Gardens

Each building design was complemented by a qualified open space plan for which the municipality set demanding design and ecological criteria. Thus the inner courts of the residential complexes became communal open spaces which, through the spec-

Central neighbourhood park



Northern neighbourhood park



ific ways they addressed the local topography, variety of plantings, rainwater infiltration areas and a dense network of internal paths, offer a variety of individualistic designed spaces. Access from the public streets does not detract from their uses; most courts have a secluded character and provide safe play space for children.

Almost every home has private outdoor space: ground floor apartments usually have terraces and rented gardens across the inner courts, and apartments on the upper floors have balconies, loggias or rooftop terraces. Private gardens for the terraced houses extend the overall concept.



Literature

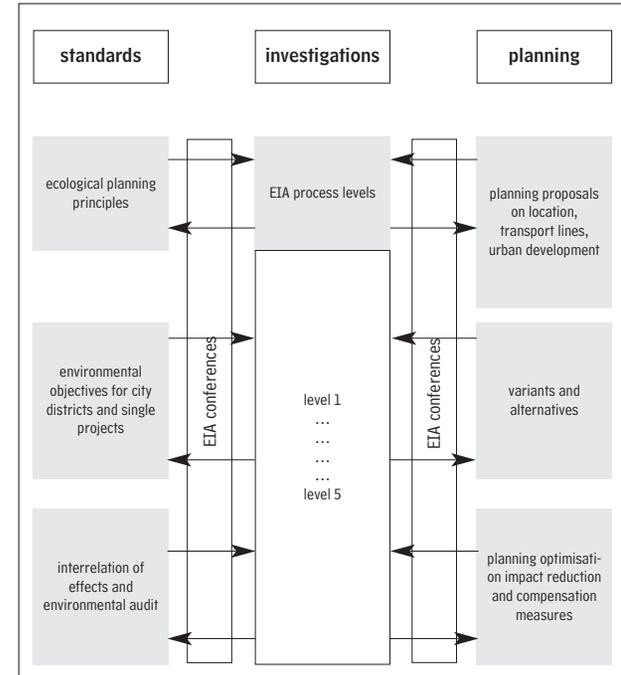
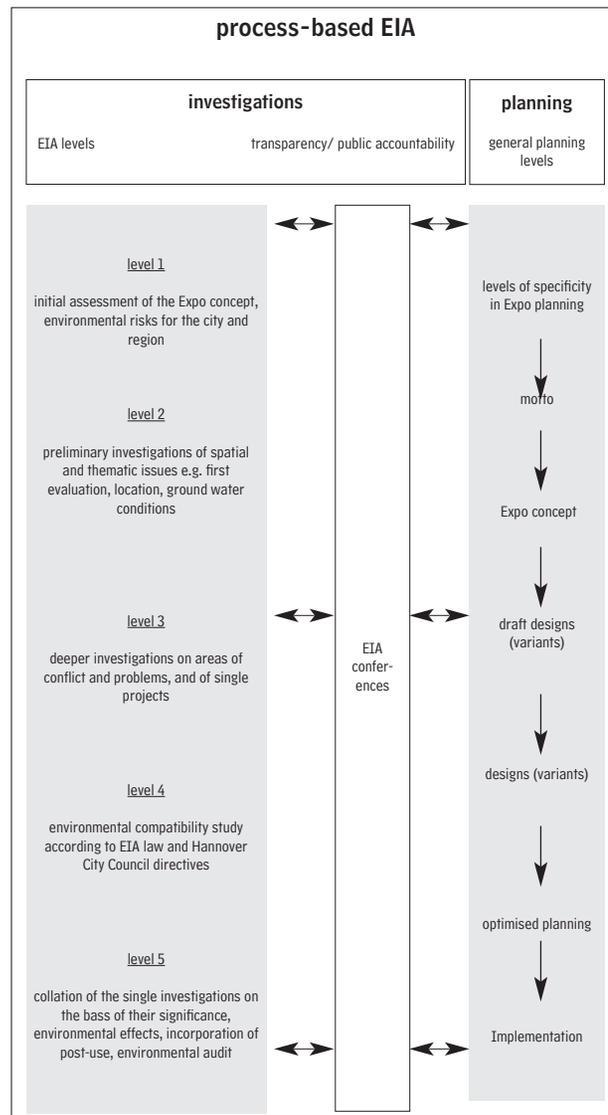
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SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

2. Urban Planning Instruments

2.1 PROCESS-BASED ENVIRONMENTAL IMPACT ANALYSIS FOR EXPO 2000

The Process-based Environmental Impact Analysis developed within the EXPO 2000 planning process must be seen as a crucial extension and supplementation of the available planning instruments. Right from the initial planning phases for EXPO 2000, in 1990 the



City of Hannover took on the task of ascertaining the environmental consequences of all measures connected with staging the World Exposition through a process-based Environmental Impact Analysis. Within the process EIA, specific assessment and checking commissions were given to planning offices and partnerships who could demonstrate previous experience with EIA. The general public was involved in the process through EIA conferences.

Concept and Responsibilities

The main responsibility for the process EIA was a planning task in the spirit of exercising a creative influence on project planning and assessing the environmental consequences. This task may ideally be graded at five monitoring levels.

Level 1

In the early stages an initial assessment of the environmental risks posed by the entire EXPO event for the Hannover Region was necessary. This level of investigation also served to identify problem areas and risks to be addressed in further planning and monitoring procedures (ecological accounting).

Level 2

There followed preliminary investigations to clarify thematic and spatial issues to create a basis for decision-making in the early stages of project development (first assessment of possible locations for the EXPO grounds, public transport scenarios, ground water surveys and, for instance, a preliminary study on management of excavated soil).

Level 3

Subsequently, more in-depth studies and comparative EIAs were undertaken on project variants (integrated EIA on the EXPO 2000 development procedures, environmental compatibility studies for the Kronsberg framework plan, preliminary studies on environmental effects of energy provision variants).

Level 4

This level comprised EIA studies on projects requiring urban planning and development permission (EIA in the planning permission procedure e.g., for the new tramline, the local rapid transit rail network and the Kronsberg road intersection, EIA at development plan level).

Level 5

Finally, the overall environmental accounting procedure begun at Level 1 was continued using findings from the individual EIA studies (environmental accounting within the development of the Kronsberg urban countryside, for the decentral Expo projects and the EXPO grounds; accounting for the regional developments deriving from EXPO 2000 was intended but not carried out.)

Stringency in planning, depth of investigation and database width increased from one level to the next. The subjects and methodologies of all investigations were coordinated and interim findings were exchanged between and used by the different fields. The decisive factor in the success of the individual monitoring levels was the guaranteed transfer of findings from the environmental investigations, to be fed into subsequent planning stages.

Aims

A comprehensive EIA on a major event such as EXPO 2000 had to be an ongoing process through to the post-utilisation phase, extending over at least ten years, in that many of the separate measures are taken up, not simultaneously but in an interdependent sequence.

For this reason the process EIA concept began with the initial planning process and accompanied the entire planning process, bringing its findings to bear on every single planning stage. The primary objective was, right from the earliest planning stages, to go beyond issuing warnings about ecological risks to taking a proactive creative role in guiding the process.

Aiming to make the planning and monitoring process open and understandable, professional target groups were involved in EIA conferences. The conferences were more than a communication channel between planners of different organisational units within the city administration, neighbouring municipalities, the state of Lower Saxony and the Greater Hannover Local Government Association (KGH). They also involved professionals from academia and research, representatives of environment associations and the various EXPO 2000 working groups. The EIA conference thus functioned as a critical filter in the planning and monitoring process.

Results and Incorporation in the Planning Process

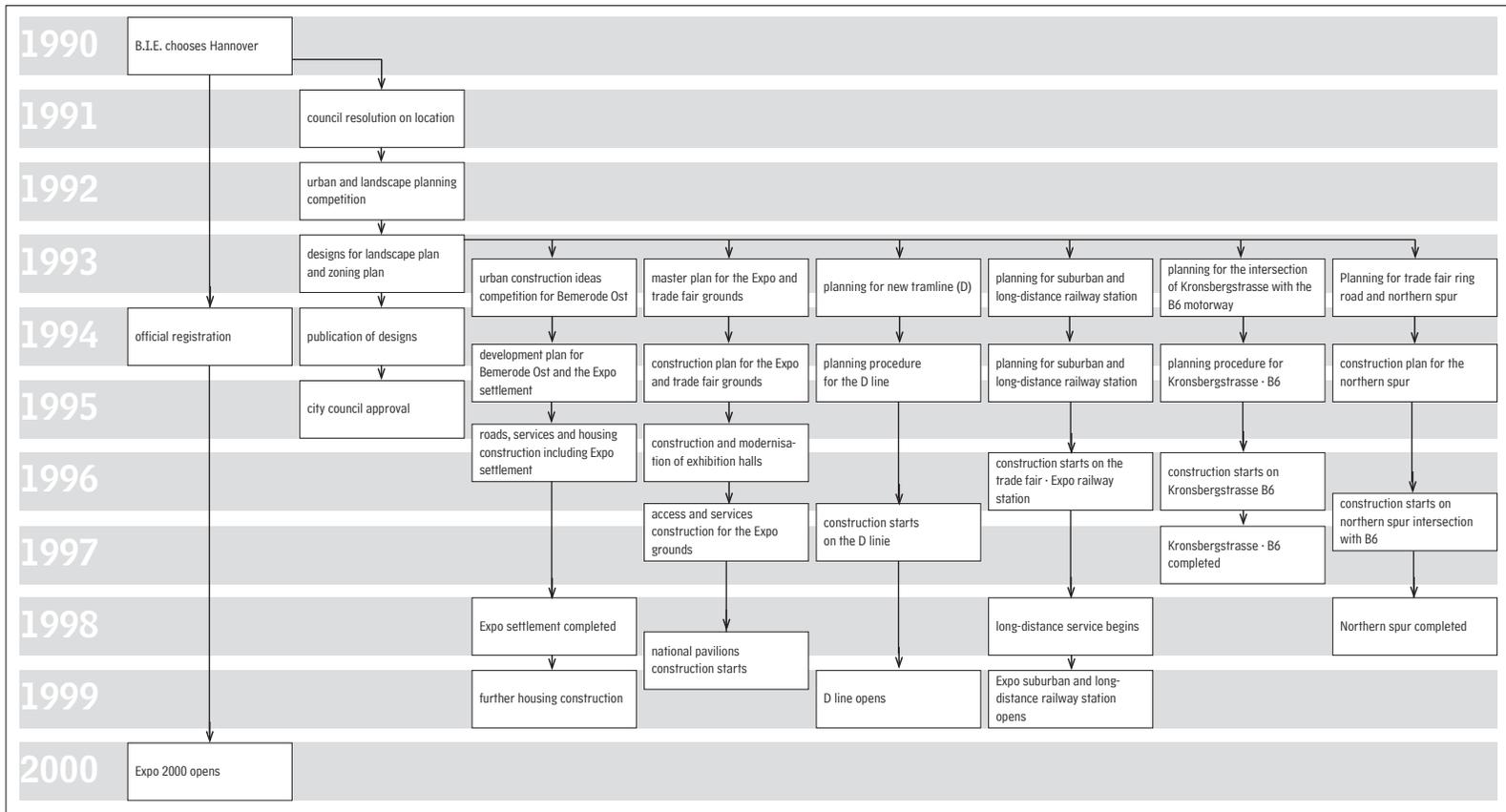
At every stage of the planning process the findings from the EIA served as a basis for decisions to be taken in the City Council. Environmental monitoring throughout the construction supervision applied a comprehensive environmental compatibility study on the Kronsberg framework plan and was continued in the preliminary studies for two urban/landscape design competitions. The ecological preliminary study was carried out by the Environment Directorate's K/2000 group and oriented on the findings of the previous process EIA investigations.

Participants in both competitions received comprehensive information. As the basis for long-term planning and design, the EIA findings from on-site investigations, from the studies of the Kronsberg framework plan and the climate and ground water studies were to be taken into account.

With the competitions, three EIA levels had already been passed (initial assessment, EIA for the Kronsberg framework plan and preliminary ecological assessment of the competition entries), which, in the spirit of the process EIA, could optimise planning on ecological considerations. The EIA findings were of particular value as the essential basis for planning an environmentally compatible Kronsberg building development:

SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

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- Based on up-to-date, differentiated vegetation surveys, it was possible to respect and retain valuable biotope structures, some of them very small.
- Findings on the chain of cause and effect in water resources and predictions of the consequences of land use changes resulted in demands for a rainwater infiltration concept at an early stage.
- Findings on the effects on and changes to the microclimate on the western side of Kronsberg hill could be incorporated in the planning.
- Based on a preliminary study of probable quantities and possible uses of excavated soil, criteria for soil management could be applied to the development plans and drafting the development and land sale contracts.

Literature

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2.2 URBAN AND LANDSCAPE PLANNING COMPETITION

As the initial planning basis for Kronsberg, in 1992 Hannover City Council and the State of Lower Saxony announced an international urban and landscape planning competition. The aim was to devise a structural concept for the entire trade fair / Kronsberg area, in which the World Exposition could be incorporated as a temporary use in 2000. While the procedure of a competition as a means of collecting ideas was already familiar, the essential difference here was that it was announced for interdisciplinary teams, to acquire solutions that addressed and answered the complexities of the new vision.

Concept and Responsibilities

The urban and landscape planning competition was limited to 'planning teams' comprising a minimum of an architect, an urban planner and a landscape architect. It was also recommended that experts, for instance on transport and ecology, should be co-opted. To enable them to assess the ecological conditions, competitors were provided with all EIA findings so far. For the discussion and definition of the task, particular value was placed on compulsory colloquia.

The competition brief was to devise a concept for the World Exposition grounds, including the trade fair grounds with its existing infrastructure facilities, and integrating it in the overall trade fair / Kronsberg concept. Part of the brief was also to create an open space concept for the World Exposition grounds and the EXPO Settlement, and organisational and construction work structures for the exhibition areas of the EXPO Corporation and participants.

Specific demands included devising ecologically stable, semi-natural countryside spaces and the Kronsberg settlement. Further aspects were improvements to the transport infrastructure around the trade fair and Kronsberg, modernisation of the trade fair grounds through to and beyond 2000, and built and landscape links between the trade fair, south Kronsberg and the town of Laatzen.

With respect to post-use, a landscape concept was required that would take into account both the various demands on use and ecological compensation and replacement measures. Post-use should be linked, spatially and functionally, with existing or future

residential and service areas. Along with a concept for the transition from EXPO use into the desired long-term uses, constructional and spatial elements were to be sought that could be developed out of the World Exposition concept.

Aims

The declared competition aim was development of a structural concept that, on the one hand, would meet the demands of a World Exposition in the year 2000 and, on the other hand, incorporate post-utilisation of the World Exposition grounds in an ecologically compatible overall concept for Kronsberg.

Following the EXPO motto 'Humankind – Nature – Technology', the aim was to devise an urban and landscape planning structure for the entire trade fair / Kronsberg area, incorporating ecological concerns in an exemplary manner. Residential, commercial and recreational needs were to be incorporated, both ecologically and socially responsibly, in high quality designs for the natural surroundings. Use of natural resources and energy should be kept as low as possible, and environmental pollution minimised.

For the countryside spaces, the essential planning aims were a shift to ecologically-responsible agriculture in the form of environmentally-compatible farming structures, enhancement of species diversity, biotope protection by creating habitats for flora and fauna, and improvements to local recreation amenity value by enhancing the natural qualities of the landscape.

It was expected from all competitors that they applied and demonstrated ecological planning principles in their designs; the objective was to improve the environmental quality of the area despite the change of use on Kronsberg. Along with the principle of 'conserving' natural resources, that of 'shaping' environmental quality was also to be applied, aiming for an ecological balance that, in spite of the construction impact, would represent a net gain for the Kronsberg countryside.



SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

2. Urban Planning Instruments

Competition Results and Incorporation in the Planning Process

Prizewinners Arnaboldi, Cavadini and Hager (Locarno & Zurich) devised a stringent, space saving design which presented the World Exhibition grounds, the new settlement and the commercial area in Anderten on the Mittellandkanal as major geometrical forms of 'autonomous citadels'. These urban elements are clearly separated from the countryside spaces and define a new city limit. The Kronsberg countryside was thus drawn into the actual centre. It would remain undeveloped and emphasised with open access hilltop woodland. At the foot of Kronsberg hill would lie the new residential district, a strictly ordered line of development whose grid structure would contain a mixture of multi-storey apartment blocks and houses.

The jury recommended the first prize design as the basis for further development, while incorporating elements of the other prize-winning designs. In particular, the landscape planning proposals of the second prize design were to be taken into account - the design of the San Remo group foresaw a 'nature park axis' along the crest of Kronsberg hill, to be shaped as a 'nature promenade of the future' with various thematic zones.

Following the structure competition and based on the competition results, an urban construction competition for residential areas for the western slope of Kronsberg hill was conducted. Further, the competition results had a marked influence on the zoning plan and landscape planning.

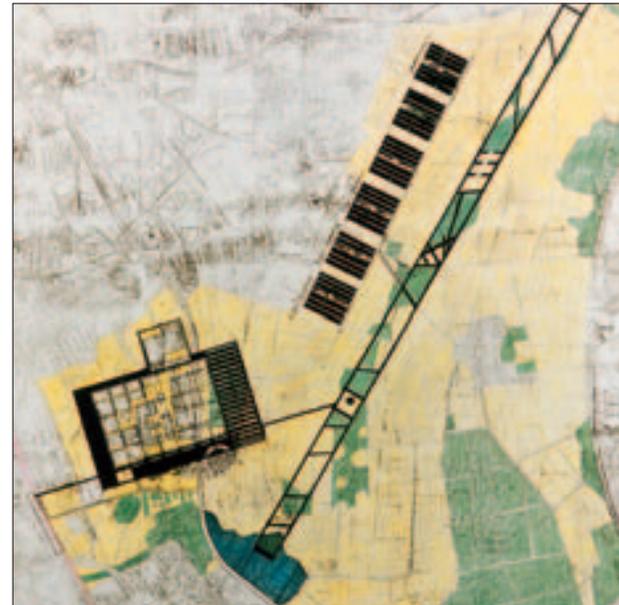
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- Wettbewerbsergebnisse, stadt- und landschaftsplanerischer Ideenwettbewerb: Weltausstellung EXPO 2000 in Verbindung mit Strukturkonzept Bereich Messe/Kronsberg, LHH Baudezernat u. Land Niedersachsen, 1992

Urban and landscape planning competition, 1st prize: Arnaboldi, Cavadini, Hager, November 1992



Planning competition, 2nd prize: SAN REMO group



2.3 URBAN DESIGN AND CONSTRUCTION COMPETITION FOR BEMERODE OST

Building on the urban and landscape planning competition, in 1993 Hannover City Council announced an urban construction competition to define planning for the new residential settlement of 'Bemerode Ost' as part of the entire Kronsberg development. On the western slopes of Kronsberg hill to the east of Bemerode, hitherto used as agriculture land, by the year 2000 a new city district with a total of 6,000 dwellings and the associated infrastructure should be constructed. For this competition, too, participants were supplied with comprehensive information from the EIA. In advance of the competition, the City of Hannover ran experts' workshops on 'Ecological Planning and Construction' and 'Healthy and Social Habitation'. The workshops' findings were also passed to competition participants along with the ecological and social planning catalogue of requirements.

Concept and Responsibilities

The competition was announced as an open urban construction ideas competition for entrants working in Lower Saxony, Hamburg, Bremen and Saxony-Anhalt. Other offices from outside this area participated by invitation. For this competition, too, the inclusion of specialists, particularly on ecological matters, was recommended.

The competition brief was to develop concepts for the planning of residential areas, greenspace and open spaces. Part of the task was to prove the feasibility of various residential development programmes within a developed access and services system. From the competition results, the design basis for drafting the building plan was to be prepared.

The area addressed by the competition covered 160 hectares. The task was to devise a district of high building density to reduce land take, aiming for an average floorspace index of 0.8 across the entire site with a mix of three and four-storey buildings.

Aims

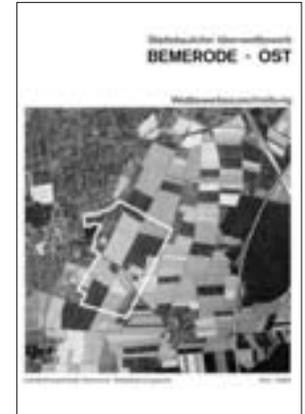
In this competition, too, an exemplary concept was sought that would take account of ecological issues in the planning. Primary objectives were sparing use of energy resources, reduction of

harmful emissions and the greatest possible use of renewable energies for the necessary provision. To reduce heating demand, suitable built structures with compact forms were to be devised. Among the planning objectives was a minimisation of built-up and paved areas, and for rainwater retention and infiltration, green spaces of sufficient dimensions were foreseen.

Along with the ecological conditions, social planning aspects had priority in the planning. The essential objective was the creation of a balanced social structure through providing a varied range of accommodation. To guarantee services close to home, communal spaces were to be planned in, to be used as appropriate for social infrastructure amenities. Service amenities such as shops, doctors' surgeries, restaurants, post office and banks were to be integrated as far as possible in the apartment blocks. Low land take, sensible combinations of infrastructure amenities, especially of schools and kindergartens, were to be examined.

A particular objective was to enhance the special, unmistakable character of the district. The building dimensions were to be planned so that existing ecologically valuable areas and those with appropriate development potential could be saved. With the planning of diverse and connected areas of vegetation, intrusion in the landscape by building measures was to be minimised, and a diverse system of green and open spaces, also as biotope chain, to be developed.

The new district was seen as more than just a housing estate, rather as a multi-use city district with its own identity. Many different housing forms should be mixed on as small a scale as possible with other uses such as offices, services and social amenities. A further objective was the development of a robust access and utilities system not tied solely to specific housing or habitation forms. The utilities structure should therefore allow the creation of development plots of differing sizes as the basis for a variety of use and development forms. The transport concept was to foresee traffic calming within the residential areas, be aligned to public transport with the new tramline and include an attractive cycle- and footpath network.



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2. Urban Planning Instruments

Results and Incorporation in the Planning Process

First prize went to the Braunschweig office of Welp/Welp and Sawadda, whose design was chosen for its simple grid access and utilities structure allowing various forms of building development. Proposals were formulated for block forms and pavilions on 75-metre square sites. The form and dimensions of the selected urban construction pattern enhanced a concept with various types of accommodation. The grid offered the chance to create urban quality public open space in deliberate contrast to the adjoining countryside. The location of the tramline parallel to the edge of the settlement was planned because of the high density development along this line. The compact development forms in the district require less land and the uphill area could thus be left open. The close network of streets was criticised by the jury on account of the high land take for traffic space, but regarded as



*Urban planning competition for the
Kronsberg district, 1st prize: H. Welp,
November 1993*



Kronsberg settlement

capable of improvement. Another critical point was that the proposed single building construction methods would make installation of district heating difficult and be unsuited to passive solar energy systems. The proposed building types should thus be more strongly differentiated in subsequent elaboration of the plans.

Building on the results of the urban construction competition, there later emerged a simple framework concept that became the basis for the building plan and the project development. Further design competitions for single construction projects followed.

Literature

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- Städtebaulicher Ideenwettbewerb Bemerode-Ost Hannover, Wett-bewerbe aktuell 2/1994

2.4 FROM LANDSCAPE PLAN TO ZONING PLAN

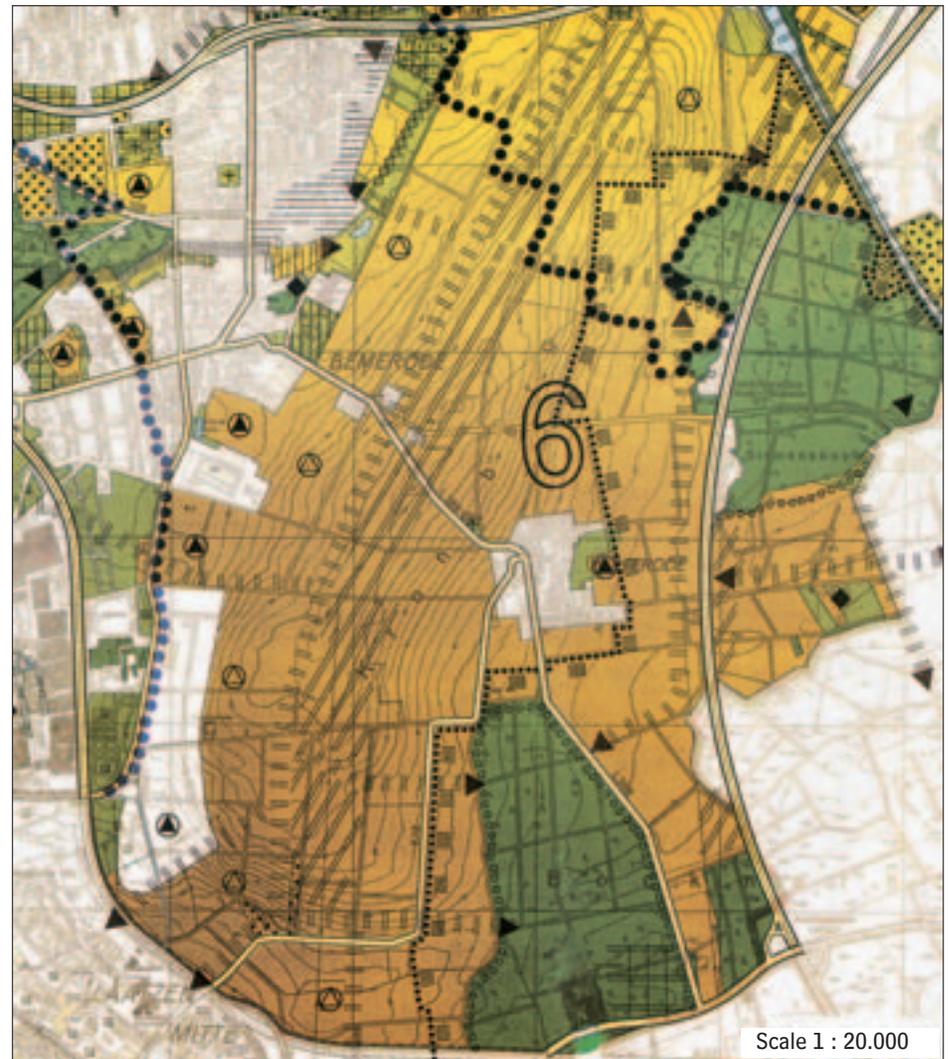
Open space planning for the Kronsberg district is essentially based on the area landscape plan, whose main lines had been approved by Hannover City Council in 1987. Its primary aim was to improve the recreational amenity value of the area. This plan led to afforestation of the crest of the hill and establishment of various green pathways. The landscape plan was updated in the context of the World Exposition and the new Kronsberg settlement.

The comprehensive planning concept created the crucial preconditions for the range of public greenspace in the Kronsberg district. Enhancement of the Kronsberg countryside was also, however, intended to benefit residents of neighbouring districts.

Concept and Responsibilities

The 1987 landscape plan was revised according to the more ambitious planning objectives EXPO 2000 and the new Kronsberg city district and to take into account new information such as that gathered during the EIA. For this revision, a landscape planning study was also completed that primarily addressed nature conservation and landscape care objectives. This study formed the basis of the landscape plan, which took account of the urban planning objectives for the new Kronsberg city district and designs for the World Exposition. To accumulate tangible design proposals for the countryside adjoining the new district, a workshop involving five landscape planning offices was held in 1994. From the workshop findings, the proposal of the Kienast office was taken as the basis for further design measures on Kronsberg. The Kienast framework concept foresaw spatial organisation of the new urban/rural landscape with five transverse park corridors and the longitudinal parkland and wood-

land planting on the crest of the hill. Proposals were also presented for the detailed design of these park corridors. The essential elements of this concept were incorporated in the Kronsberg landscape plan.



LANDSCAPE FRAMEWORK PLAN

-  enhancement – over 750 metres to larger open space
-  enhancement – 300 < 750 metres to larger open space
-  establishment of near-natural woodland
-  increased proportion of woodland
-  improvements to woodland margins
-  reinstatement of natural watercourses

SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

2. Urban Planning Instruments



Aims

The Kronsberg landscape and its importance as recreational amenity and natural space should be enhanced; relevant objectives for the settlement area were defined within the open space planning, aiming at minimisation of changes to the soil structure, deliberate encouragement of local soil types and reuse of excavated soil within the area. Another explicit objective was to minimise the amount of land covered by building and paving, helping infiltration of precipitation within the built-up areas to maintain stable ground water levels. Valuable vegetation was to be retained and the open spaces between the development and the hilltop woodland enhanced as a functioning, ecologically effective buffer zone.

Particular attention was paid to the construction of typical local structures, and the connection of habitats with green areas and semi-natural development of public greenspace was seen as important. Planning objectives included preservation of the local topography, establishment of clear boundaries between settlement and countryside, plantation of the district margins and placing the lower buildings closer to the countryside.

Results and Integration in the Planning Process

One important element of the landscape plan was extension of the hilltop woodland and sectioning the residential development on the western hillside with green corridors. On the southeastern end of Kronsberg hill regional long-distance foot- and cycle paths were laid out. Expansion of main footpaths and structures, and tree and hedge planting enhanced Kronsberg as a local recreation area. Agriculture across the entire area has shifted to extensive methods. The existing biotope potential was further enhanced by designating locations for wetland, dry grassland and field wild plant societies.

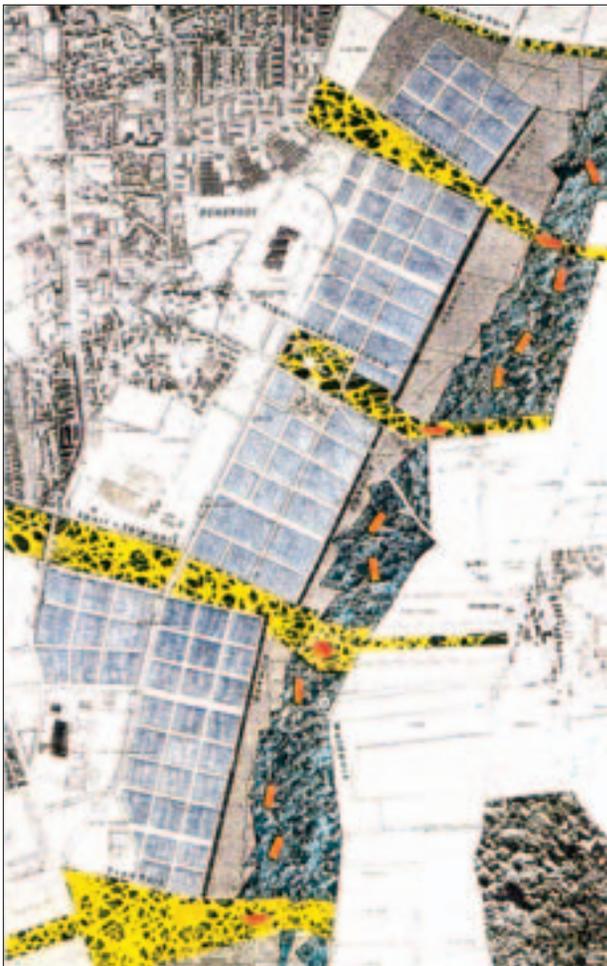
Achievement of the planning aims on Kronsberg led to an extensive reshaping of what had hitherto been mainly agriculture land. On the one hand, the new settlement meant the loss of natural resources under built-up areas, increases in emissions and increased pressure on the marginal areas. On the other hand, taking account of ecological aims and landscape planning measures led to an increase in the proportion of woodland, structuring of the landscape and the establishment of typical local biotopes.

Shaping of the landscape and open space planning in the new district was applied according to the development aims as set out in the landscape plan and the urban design process. The essential aims of the landscape plan are legally effective through their inclusion in the zoning plan, and the results of the open space planning process were integrated in the development plans.

Literature

- 49. Änderungsverfahren zum Flächennutzungsplan Hannover, Bereich: Kronsberg, Beschlussdrucksache 578/94
- Freiraumplanung Stadtteil Kronsberg, LHH Baudezernat, Planungsgruppe Weltausstellung, Hannover 1995
- Hannover Kronsberg, Realisierung einer nachhaltigen Planung, Hrsg. KUKA und LHH, 3. überarbeitete Auflage 05/20

Kronsberg & EXPO Park Design: Kienast, July 1994



View from the west

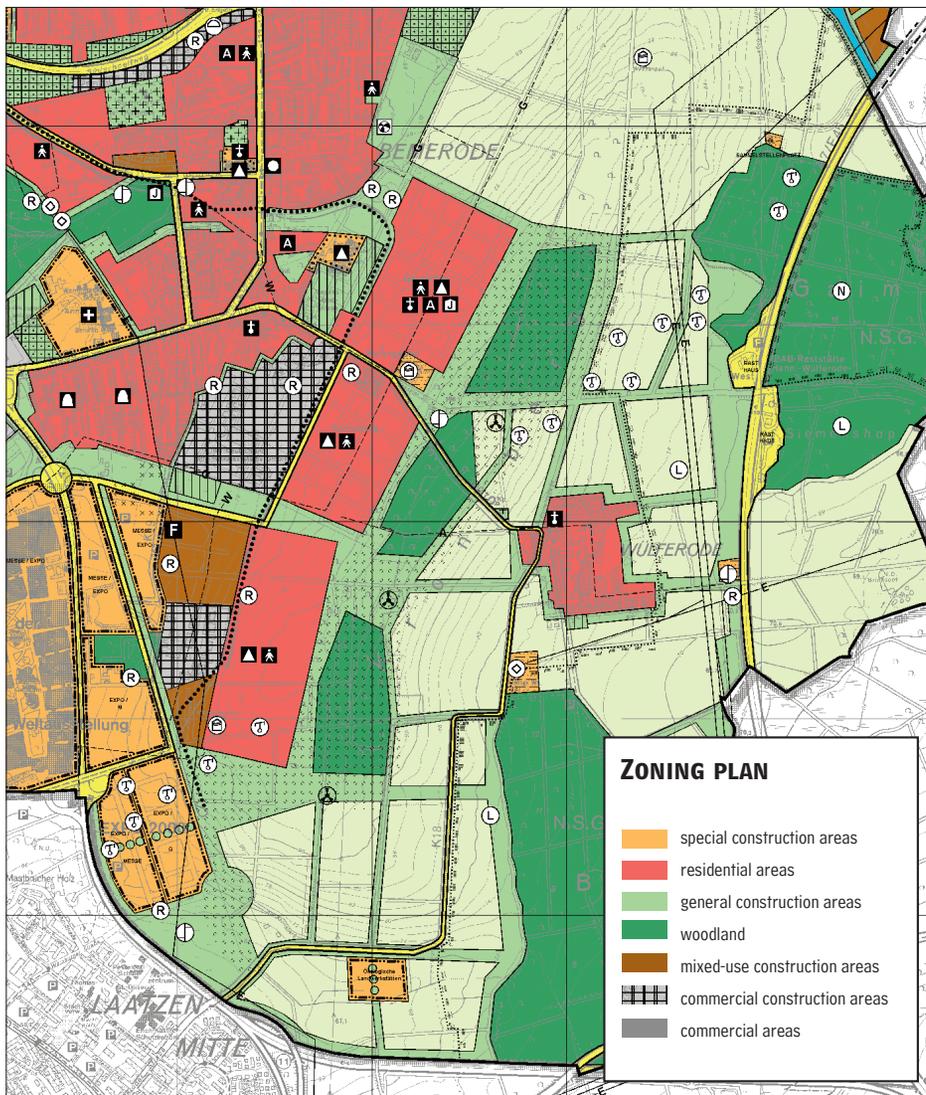


SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

2. Urban Planning Instruments

2.5 ZONING PLAN

The prerequisite for implementation of planning for Kronsberg was the 49th alteration to the zoning plan as approved by Hannover City Council in 1994.



Concept and Responsibilities

Because of the strong demand on the housing market in the early 1990s and increased need for accommodation during EXPO 2000, the alterations to the zoning plan primarily designated new residential areas on Kronsberg; as the last remaining large area of reserve settlement land within the city limits it offered potential for settlement development with up to 10,000 dwellings and the necessary infrastructure.

Furthermore, the zoning plan took account of the spatial demands of the World Exposition, based on the revised version of the first prize in the urban and landscape planning competition. EXPO 2000 temporary utilisation was of considerable benefit to framework conditions for long-term urban development in the entire Kronsberg area. Along with long-term improvements to the location factors on the trade fair grounds, an excellent transport infrastructure was provided from the start of the Kronsberg development.

To assess the various possibilities for settlement development on Kronsberg, different investigations and assessments to discern the ecological effects were completed. The basis for alterations to the zoning plan was above all the preliminary investigations of environmentally relevant consequences for the area concepts and the public transport components within the process EIA.

To be able to assess the many and varied consequences of the building measures, an Environmental Impact Analysis (level 3 of the process EIA), a ground water study and a climate study were completed. Additionally, the results of a landscape planning study and the findings of a hydrological study on possible infiltration measures, and the study, 'Woodland areas around Kronsberg – study of susceptibility to ground water shrinkage and heavy demands for recreational purposes' were all taken into account.

Aims

The findings of the Environmental Impact Study showed that implementation of the building works as foreseen in the framework plan would lead to serious ecological conflicts with regard to ground water table, flora and fauna, soil, and local climatic conditions. This was especially true of the south and southwest slopes of Kronsberg hill, where the flora and fauna were particularly

sensitive to change and which also represented an important climatic compensation area for the neighbouring town of Laatzen.

The main residential development was therefore located in the Bemerode-Ost area on the northwest side of Kronsberg hill, in two clusters north and south of Wülferoder Strasse totalling about 3,500 dwellings. The total land requirement could, however, not be met here, so that areas for residential development to the south (c. 2,500 dwellings) also had to be designated. Close connections with the district of Bemerode and the economic viability of the tramline were thus secured. In discussion of the planning objectives, various development options were compared. The long expansion of the settlement at the western foot of Kronsberg hill presented some advantages: the ecologically sensitive southern slopes of the hill would thus remain undeveloped, and all the new dwellings would stand in a clear spatial relationship to each other, producing advantages for the arrangement and use of infrastructure amenities. Furthermore, the 6,000 dwellings could be served by tram stops at regular intervals.

In laying out the new residential district, creation of an urban quality with a balanced social structure was to be foregrounded. The planning objective was to establish a balanced mix of publicly subsidised and privately financed housing. Through appropriate planning and specific financing profiles, the housing was to be made attractive to a wide range of various property developers and clients.

In the new residential development areas innovative, environmentally responsible forms of urban construction were to be implemented in exemplary fashion. The aim was to use the spatial potential to the full, for ecological reasons, and for efficient access to the new tramline. Planning aimed at an average floorspace index of 0.8 across the net building land. For the residential quarters, a mix of apartment blocks of three or four storeys and closely spaced mainly two-storey dwellings were foreseen. Along with owner-occupier dwellings and rented apartments, terraced houses were to be incorporated in the planning. Around a third of the area was designated for infrastructure, access and public greenspace.

Results and Incorporation in the Planning Process

The extent and location of the residential development areas was derived from the factors of housing demand, access and utilities possibilities, economic viability of the tramline connection, relationship to existing residential areas, ecological compatibility and topography.

The overall concept for development on the western slope of the hill made it possible to build in several phases, thus responding flexibly to the needs of the city's development.

The 49th amendment to the land use plan was planning as process; as it went through progressively more concrete phases new findings and knowledge were continually evaluated and applied, mainly:

- findings from the advance citizens participation process
- results of the development procedure, 'Weltausstellung EXPO 2000'
- partial findings of the process Environmental Impact Analysis
- results of the two planning competitions including revision of the first prize design
- updating of the Kronsberg landscape plan
- results from consultation with public bodies and publication of the draft plans and
- the results of the ground water and climate studies.

Presentation of the residential development areas in the zoning plan defines the framework for further development of built structures in the building plan.

Literature

- 49. Änderung zum Flächennutzungsplan Hannover, Bereich Kronsberg, Beschlussdrucksache 1394/94, LHH 1994

SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

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PART OF THE DEVELOPMENT PLAN FOR KRONSBERG NORD



2.6 DEVELOPMENT PLAN

The Development Plan was based on the reworked first prize submission in the urban development design competition for Bemerode Ost. The Kronsberg district is covered by Development Plans No. 1551 for the 'Kronsberg-Nord' section, No. 1552 for 'Kronsberg-Mitte' and No. 1553 for the yet-to-be-built 'Kronsberg-Süd'. All three were developed from presentations of the city zoning plan.

For implementing the ecological objectives, the well-tried instrument of the development plan was applied, in which the essential targets for investors and developers, building plot owners and planning applicants were defined.

Concept and Responsibilities

The development area lies to the east of the city district of Bemerode on what was hitherto almost entirely arable farmland. The concept as it emerged from the urban planning competition shows a clearly defined residential area lying along the new tramline and presenting a clear contrast to the adjacent countryside, bounded to the east by a kilometre-long avenue, and by the 'Basisstrasse' beside the tramline as the main access road.

Creation of the Development Plan for the western side of Kronsberg hill set the planning conditions for construction of the new district with around 6,000 homes and the concomitant infrastructure for 12–15,000 people. Kronsberg is the only area within Hannover city limits suitable for a residential development of this magnitude, and its development was thus necessary to meet the urgent housing demand.

A survey was carried out to be able to assess the environmental consequences of construction on nature and the countryside: EIAs on the Kronsberg framework plan and landscape plan, and expert assessments of environmentally relevant issues such as ground water and climate, contained qualified statements on the current situation and on dealing with the consequences of development. The comprehensiveness of the available material made possible a competent open space planning within the development plan, rendering a special greenspace plan unnecessary. Definition of construction and traffic areas on Kronsberg, which

the demand for residential development land had made unavoidable, implied serious disruption to the ecological balance. Encroachment on the natural landscape comprised around 291,000 m² construction area, c. 23,000 m² for communal needs, c. 123,000 m² for transport and around 9,000 m² additional land for a reservoir in the south-east of the planning area. Disruption by the development was particularly severe through paving and built-up areas sealing land, soil compaction, and destruction of soil morphology and geological structures. Ground water recharge was reduced and ground water level lowered. Clearing vegetation in field margins and verges destroyed habitats of endangered flora and fauna. Climatic compensation was reduced, and pollution increased during weather inversion.

Part of the essential tasks of the development planning was to define measures that would minimise or compensate for the environmental effects of construction, or replace lost ecological resources and functions.

Aims

In accordance with the results of the planning competition, the urban development objective was a wide-spaced grid of blocks as framework for various construction forms, with development sections of comparable size. Each neighbourhood was to contain eight blocks grouped around a central park. Built structures become lower and less dense towards the countryside, and thus the densest use was foreseen close to the tramline along the main access road.

Along this 'Basisstrasse', an uninterrupted line of four-storey buildings was planned to present a unified townscape from the outside while secluding the inner courts. In the downhill area, planning objectives included small-scale mix of housing, workplaces and services, the middle area foresaw three-storey structures such as pavilions alternating with the central neighbourhood parks, and the uphill area was to contain three-storey buildings and, to the east of them, groups of two-storey houses on the edge of the countryside.

The district square, with an arts and community centre, a health centre, an ecumenical church centre, youth club and community social service, was assigned to the northern side of Wülferoder



View from the north

Strasse. Its form was to be left as open as possible, as a town planning competition was planned for a later date. The preferred locations for shops were to be the district square and on ground floors of houses along the main access road.

From the main axis of this 'Basisstrasse', access to the district was to be a grid of streets in accordance with the design competition results: streets running uphill should distribute traffic, while the north-south streets should be solely for connections between adjacent buildings. On the access roads, precipitation was to be retained and infiltrated on site, the necessary infiltration trenches set between parking bays and footpaths, integrated in the street design.

Results and Incorporation in the Planning Process

In accordance with the urban construction planning aims, construction areas on the 'Basisstrasse' were defined as mixed use areas, and the remaining blocks as general residential areas. The predefined surface area index and floorspace index allowed construction of the desired number of dwellings. Setting building lines for the lower and middle areas created clear edges to the structures along the street.

In the construction areas along the 'Basisstrasse', except for the district square an uninterrupted house front with four full storeys was insisted upon, and to achieve unified urban contours, three full storeys were defined for the middle zone. The transitional area between these zones could be of three to four storeys. On the

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eastern side of the uphill area, as a transition to open countryside, open-plan construction was determined on the basis that only groups of houses (terraced or otherwise linked) were allowed.

Areas for schools and pre-school facilities were allotted in the planning area on the basis of perceived demand. Other necessary amenities were to be located on the district square. In the mixed-use area or the general residential areas, accommodation for the elderly was to be included at a suitable location. Areas for communal facilities were not predetermined, to allow for choice on the basis of the exact location within the planning area.



View from the south



Extensive conditions as laid down in the Development Plan made it possible to compensate to a large extent for disruption of the local ecological balance. Concurrently, this resulted in semi-natural open space designs and enhancement of greenspace potential as common and recreational space. Disruption of water resources was compensated for by infiltration or delayed release of precipitation in the 'Mulden-Rigolen' system of soakaway trenches.

In the construction and communal use areas the following minimisation and compensation measures were determined:

- exclusion of outbuildings from the inner courts in each block development, to leave these areas open for tenants' gardens and communal use
- exclusion or limitations on exceeding the permitted built area index more closely defined in the Development Plan
- ordering of public parking spaces with tree planting (a tree for every five spaces)
- an obligation that paving of parking spaces and access roads on the construction blocks should allow rainwater infiltration
- an obligation to plant a tree for every 200 m² or part thereof in built-up or paved areas in mixed-use areas
- an obligation to plant a tree for every 100 m² or part thereof in built-up or paved area in general residential areas
- an obligation to plant a tree or five shrubs for every 200 m² or part thereof in built-up or paved areas for communal use
- an obligation to plant roofs of underground garages not below buildings
- an obligation to plant all roofs of less than 20° pitch in commercial areas
- an obligation to plant roofs of less than 20° pitch on single- or two-storey buildings or parts of buildings on the inside of blocks in mixed use areas.

Full compensation for environmental disruption was provided by a 22-metre wide stretch of open land to the east of the settlement as an area for measures serving the protection, care and enhancement of nature and the landscape. Encroachments by surfaces for traffic were compensated for with tree planting along roads, infiltration trenches and green strips. Structuring of the development area with greenspace and the semi-natural marginal areas to the east of the settlement also compensated for alterations to the landscape.

Energy provision in the district is intended to come from low-emission CHP plants. The district heating concept makes it possible to connect up to eight blocks to one CHP, and to reserve possible locations symbols were entered in the development plans.

In the area covered by Development Plans Nos. 1551 and 1552 for the completed sections Kronsberg-Nord and Kronsberg-Mitte, development contracts were concluded with private landowners to place clear conditions on construction and access development. After the main principles of the contracts had been drawn up it was decided that the necessary reshaping of the development plots and guarantee of supply line rights would be carried out through a land reallocation procedure.



Children's day centre 1 and playground



Comprehensive school under construction

Literature

- Begründung zum Bebauungsplan Nr. 1551, Anlage 1 zur Drucksache 516/95, LHH 1995

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2.7 THE KRONSBURG ADVISORY COUNCIL

Planning for the new Kronsberg district was, because of the tight schedule through to the year 2000, conducted simultaneously at all levels. This process was only possible through project development involving investors and property developers, architects, civil engineers and construction companies. The Kronsberg Advisory Council (Kronsberg-Beirat) was part of this cooperative project development.

Through ongoing advice within this cooperative procedure, the City of Hannover local authority succeeded in introducing many construction stakeholders to the new guiding principles.

Concept and Responsibilities

In the integrated planning process for the new district the Kronsberg-Beirat advised the City Council on all main design issues. The advertisement of the sale of building plots made the town planning principles as based on the competition concept clear. However, it became plain that many draft designs deviated from the general conditions of the land sale advertisement; despite the expected variety of housing forms, materials, colours of structures, and open spaces, the overall planning aim was a homogenous townscape.

The task of the Kronsberg-Beirat was to formulate recommendations and targets that would lead to implementation of a homogeneous urban design according to the planning aims. In this, the Advisory Council oriented itself on the urban construction guidelines of the competition concept and the land sale advertisement, and put them into concrete terms through experience gained from the available development concepts. The main recommendations included commissioning of neighbourhood architects to work with participating property developers and architects on the basis of agreed town planning concepts for each neighbourhood.

Aims

The essential characteristic of the urban planning concept was a clear distinction between town and countryside and building along the street lines. From these preconditions was derived the objective to establish clear-cut edges to structures and streetscapes. A further responsibility was to achieve harmony between the topography and built structures, which gave rise to the recommendation to arrange long buildings along the contours of Kronsberg hill.

Another requirement as devised by the Kronsberg Advisory Council was to create a balance between building density and usable open space; even in areas of higher density, emphasis should be placed on good open space design, and both communal inner courts and private outdoor space should be available. The totality of designed open space through the inner courts was to extend across the entire settlement as a network connected by footpaths. All main entrances should be on the street side, and the rear of the buildings should by contrast have a semi-private, quieter character.

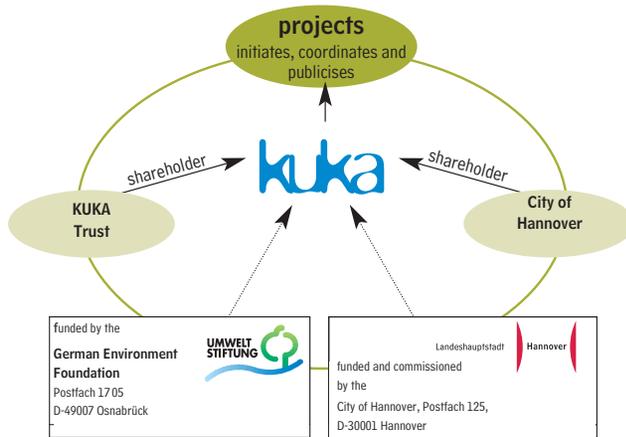
It was recommended that the water management concept with the required infiltration areas should be incorporated in the open space design concepts. Similarly, parking spaces should be integrated in the blocks by using the topography. To ensure a variety of accommodation it was recommended that different types of apartments should be designed and both individual and communal areas offered.

Results and Incorporation in the Planning Process

The advertisement of sale of building land and selection of property developers signalled the beginning of the main work of the Kronsberg Advisory Council. Its recommendations on urban design were a critical accompaniment to the entire project development and were taken into account in applying the planning objectives through land sale contracts.

Literature

- Empfehlungen zur städtebaulichen Gestaltung, Kronsberg-Beirat, Juli 1995, s. Annex 7



2.8 KRONSBERG ENVIRONMENTAL LIAISON AGENCY, KUKA GMBH

The ecologically exemplary measures implemented on Kronsberg, such as energy efficiency optimisation in dwellings, semi-natural rainwater management, waste volume minimisation, environmentally responsible transport concept and soil management during the construction phase, created conditions in the new district that demanded qualified approaches. Both for residents of the new district and for all stakeholders in the planning process missionary work was needed to secure the success of the ambitious projects. For this reason, environmental communication structures were devised to support the information and persuasion process long-term and create broad-based acceptance at the different levels.

Concept and Responsibilities

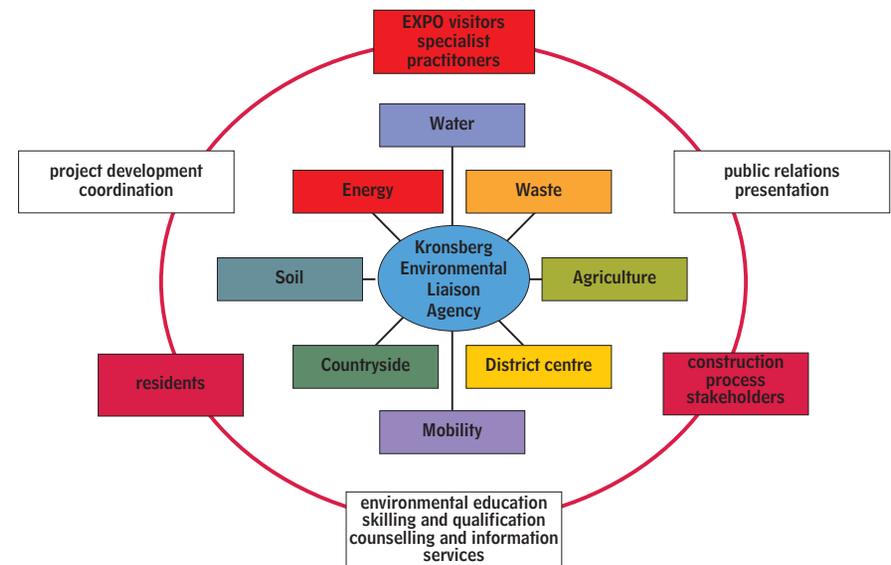
KUKA was set up in 1997 jointly by its shareholders, the City of Hannover and the 'Förderverein der Kronsberg-Umwelt-Kommunikations-Agentur e.V.' non-profit trust. Financial support by the German Environment Foundation (Deutsche Bundesstiftung Umwelt, DBU) and the City of Hannover provided the launch capital.

KUKA was intended to function as a service facility that could respond quickly and flexibly to new demands and thereby assume responsibility for guiding and applying the entire environmental communications concept for the Kronsberg district. As many jobs and commissions as possible were to be delegated to third parties, in order to focus on planning, consultation and coordination of the various activities.

Different instruments were used to ensure broad-based environmental communication across the district: along with publications such as flyers, newsletters, info-sheets and circulars there were talks, discussion events, seminars, workshops, advice surgeries and training courses, supported by visual aids such as posters, exhibitions, slide shows and computer-guided presentations.

As part of its exhibition and presentation concept, KUKA presented the sustainable district on display boards, brochures, video clips and internet, and was present at trade fairs and exhibitions, showcasing the various thematic areas and putting them in the context of sustainable urban development.

KUKA's tasks included information and public relations work with the development of client group oriented material and events, environmental education and counselling through skilling programmes, planning and implementation of exhibitions, guided tours, meetings and congresses, development and implementation of citizens' participation and project development, management and implementation.



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Skilling and qualification seminar

Aims

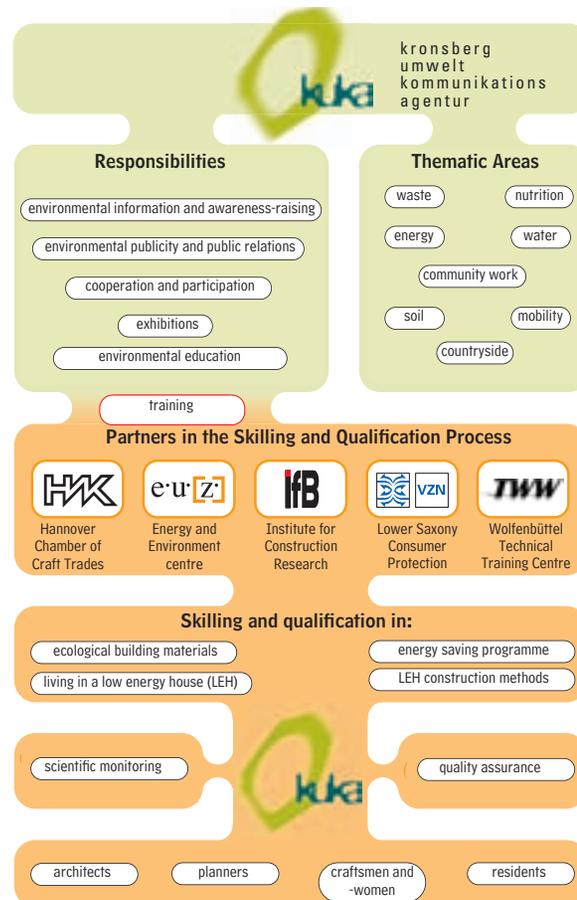
KUKA's raison d'être was to contribute to the establishment of the new district as an exemplary sustainable settlement in the spirit of Agenda 21 with all possible environmental communications strategies and means. In this the essential concern was implementation of the City of Hannover's decentral Expo project, 'Ecological Optimisation at Kronsberg'. This included presenting the district and its ecological projects to a broad specialist audience. Additionally, KUKA was briefed to test and run academic studies of the practicability of environmental communications in sustainable urban development within the 'Lernprojekt Kronsberg'. In the spirit of sustainability, the findings should be applicable to other construction schemes.

The vision statement of the KUKA concept was creation of a corporate identity to maximise identification by residents and all stakeholders with the construction process in the ecological district. The concrete working objectives were to convey information, knowledge, attitudes, values, behaviour change and opportunities for action on all aspects appertaining to living within the special conditions of the Kronsberg sustainability concept.

Client groups were, apart from people living and working on Kronsberg, planners and architects, property developers and project managers, manufacturers, craftspeople and others involved in construction. Other target groups were visitors and the interested general public, journalists and representatives of the media.

The 'Energy Project' included setting up a quality assurance monitoring programme for the Low Energy House standard, a skilling programme for architects, specialist planners and craftspeople, devising the concept, 'Learning to live in a Low Energy House' and a concept for informing and advising residents and other client groups. KUKA's five partners in this project were an energy and environment centre (Energie- und Umweltzentrum am Deister e.V, EUZ), a non-profit construction research institute (Institut für Bauforschung e.V., IfB), a technical further education centre (Technisches Weiterbildungszentrum Wolfenbüttel e.V., TWW), Lower Saxony Consumer Association (Verbraucher Zentrale Niedersachsen, VZN) and the Chamber of Craft Trades environmental protection centre (Zentrum für Umweltschutz der Handwerkskammer Hannover, HWH) in cooperation with an architectural and civil engineering practice in construction physics (Architektur- und Ingenieurbüro für Bauphysik Prof. Pohl, AIB).

Skilling and qualification of construction supervisors, foremen and craftspeople were mostly conducted on site and addressed construction techniques for specific buildings, above all for detail work on sealing and insulation. As part of the skilling and qualification concept for residents, KUKA worked with the consumer association to produce the 'Kronsberg File' for every household on making the best use of Low Energy housing. The File became a central part of KUKA's environmental communications work.



Results and Incorporation in the Planning Process

KUKA worked from 1997 as an intermediary institution between all those involved in planning and construction, residents and other users of the district, professionals, media and the general public.

Though its constant presence in the district and the establishment of communications structures, KUKA could also respond at short notice to requests for information from all parties. Close cooperation with the municipality's specialist divisions, with civil engineering and planning bureaux and with partners in the skilling and qualification programme made it possible to clear up questions quickly and establish good contacts. While KUKA was mainly active for planners and builders until the end of 1998, from early 1999 residents and other users of the district became more important client groups. KUKA prepared and applied the following concepts:

- Environmental Communications
- Cooperation Model for Skilling and Qualification
- Environmental Education
- Kronsberg Water
- Guided Tours of the District and the Kronsberg Countryside
- Presentation of the District in close cooperation with City of Hannover specialist divisions and press office.

Various measures and instruments have proven particularly suitable for implementation of an environmental communications concept. Along with applying the qualification measures within a cooperation model, the devising of the Kronsberg File was a particularly effective environmental communications measure. Other important components of the concept were application of the municipal energy saving programme for Kronsberg, intensive target-group-specific information and public relations work, application of the presentation concept, publication of the district magazine, 'Kronsberg life', and opening up possibilities for cooperation and participation. Also, the spring festival and other events in the district, participation at trade fairs and congresses, devising of special services for immigrants and the concept and implementation of the district's internal environmental education model were all important and suitable instruments of environmental communications.

KUKA also gained national recognition as an innovative institution in sustainable urban development, recognition that was stimulated by two specialist congresses on sustainable urban development, in May 2000 and November 2001. KUKA's energetic commitment gave a new impetus to interdisciplinary dialogue in urban planning, networks were extended, and synergy from similar projects was employed.

Although KUKA has been wound up, its environmental communications work will continue – albeit in limited form – as changes in awareness, values, behaviour and practical action cannot be achieved overnight. Residents will therefore have a local representative of Hannover City Council available for environmental questions at KroKuS.

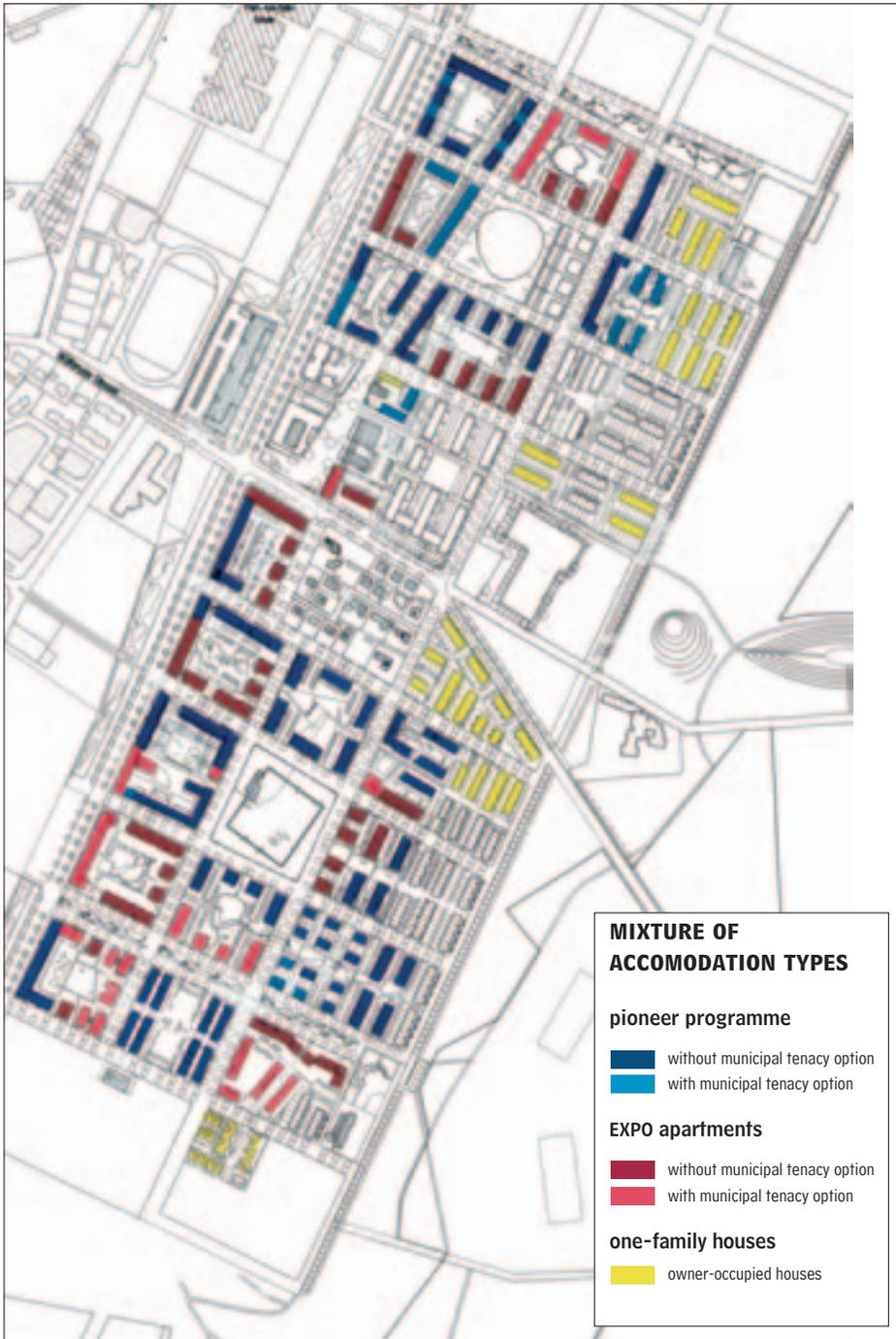


Literature

- Bauen am Kronsberg, Umweltkommunikationskonzept Kronsberg, Konzeptstudie, LHH Amt für Umweltschutz, AG Umweltplanung Weltausstellung September 1996
- Beschlussdrucksache Nr. 1309/97, Kronsberg-Umwelt-Kommunikations-Agentur GmbH, Antrag auf Förderung, LHH 1997
- Satzung des Vereins KUKA e.V., KUKA 1997
- Kronsberg-Umwelt-Kommunikations-Agentur, KUKA März 1998
- Umweltkommunikation in der nachhaltigen Stadtentwicklung, Das Umweltkommunikationskonzept der KUKA für den nachhaltigen Stadtteil Hannover-Kronsberg, KUKA Oktober 1998
- Einrichtung einer Umweltkommunikationsagentur für den Stadtteil Hannover-Kronsberg im Rahmen der Weltausstellung EXPO 2000, Abschlussbericht, KUKA Dezember 2001
- Wohnen auf dem Kronsberg, Informationen für die Bewohnerinnen und Bewohner, KUKA

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2.9 HOUSING CONSTRUCTION PROGRAMME

Planning for social balance implies a multiplicity of housing and financial forms.

The concept foresaw both privately financed owner-occupier apartments or apartments to rent and publicly subsidised apartments. A small number of owner-occupied terraced houses were also planned.

A mixture of apartment sizes should reflect the composition of society and hinder one-sided social profiles. The aim was the development of stable neighbourhoods through a variety of residents; accommodation for the disabled and elderly should also be distributed across the entire district.

A guideline for quality assurance in social housing construction sets out the single criteria.

Because of the housing market situation in the second half of the 1990s no investors could be found to risk privately financed residential development.

As a response to the forthcoming EXPO 2000 World Exposition, the City of Hannover and the State of Lower Saxony extended the building subsidies programme for house building at the Kronsberg site. Presently there are about 2,700 homes publicly supported from different funding programmes, of which 1,050 homes were used as accommodation for EXPO personnel.



The conditions for publicly subsidised accommodation eligibility had to be relaxed in order to ensure the social planning goals of a balanced population mix. The income limit, particularly, was significantly raised (for first tenants only).

Unlike other development areas, such those dating from the 1970s, there are no voids at Kronsberg and a strong demand for all apartments. Residents find the district modern, child- and family-friendly, well provided with green space and possessing a good private and public infrastructure.

Along with the 200 privately owned one-family terraced houses, the 2,678 apartments currently available on Kronsberg may be broken down by size as follows:

1 room	249	units
1 1/2 rooms	142	units
2 rooms	762	units
2 1/2 rooms	48	units
3 rooms	1045	units
3 1/2 rooms	6	units
4 rooms	388	units
4 1/2 rooms	11	units
5 or more rooms	27	units

(all plus kitchen and bathroom.)



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2.10 URBAN DEVELOPMENT CONTRACT AND LAND SALE CONTRACTS

The Kronsberg area had been marked as reserve residential development land for many years, and the municipality consistently bought up land in the area until, by the early 1990s, it owned around 80% of the development area. To establish its planning authority over all plots, the City Council passed an urban development bylaw which froze property values and granted the municipality first option on all land purchases.

In the first construction phase of about 3,000 dwellings the land ownership conditions were otherwise: here, the City owned just 60% of the total area, the remainder being mainly divided between two construction companies and two farmers. Because of the construction companies' willingness to cooperate and good relations with the farmers, who renounced their rights to develop the land for quick profit, costly and protracted compulsory purchase procedures could be dropped.

Instead, the various regulations and standards were guaranteed through a redistribution of developers' obligations to other parts of the city, two urban development contracts, and an access and services construction contract based on the development plans.

The City of Hannover defined ecological standards for private developers through clauses in the land sale contracts, applying to the following areas:

—● Energy

Low Energy House construction methods across the entire development using the Kronsberg calculation model, and obligatory connection to the district heating system.

—● Water

obligatory waste water connection to the city's sewage network, and rainwater infiltration in front of each property into the rainwater management system.

—● Construction Waste

obligatory approval of building materials and participation in the City's waste management concept.

—● Soil

obligatory participation in the soil management scheme, whereby excavated soil from foundations had to be passed to a soil management agency, an engineering bureau commissioned by the City of Hannover, for reuse. A standardised charge per cubic metre delivered was made to all participants in the scheme, and the excavated soil was used for landscaping projects.

—● Nature Conservation

regulations for tree planting, and environmental compensation measures according to Lower Saxony nature conservation law.

Along with all the conditions, the principle was established that not single standards but the overall evaluated sustainability of each construction project was the significant condition. This promoted individuality and experiments, thus facilitating praxis-based refinement of the standards.

Literature

- Grundstückskaufvertrag der Landeshauptstadt Hannover, 1997, (s. Appendix 1)
- Städtebaulicher Vertrag zwischen der Landeshauptstadt Hannover und der Immobilien Development und Beteiligungsgesellschaft Niedersachsen mbH, Hannover 1997

2.11 PUBLIC AND PRIVATE TRANSPORT

The EXPO 2000 World Exposition was also meant to be a sustainable event with regard to transport; the burden of visitors was to be roughly equally spread between tram, long distance and suburban train, bus and private car. A new tramline and railway station were among the transport infrastructure improvements.

The new tramline ran through the new Kronsberg district and the first Kronsberg residents thus had excellent public transport connections, reaching the city centre in 17 minutes.

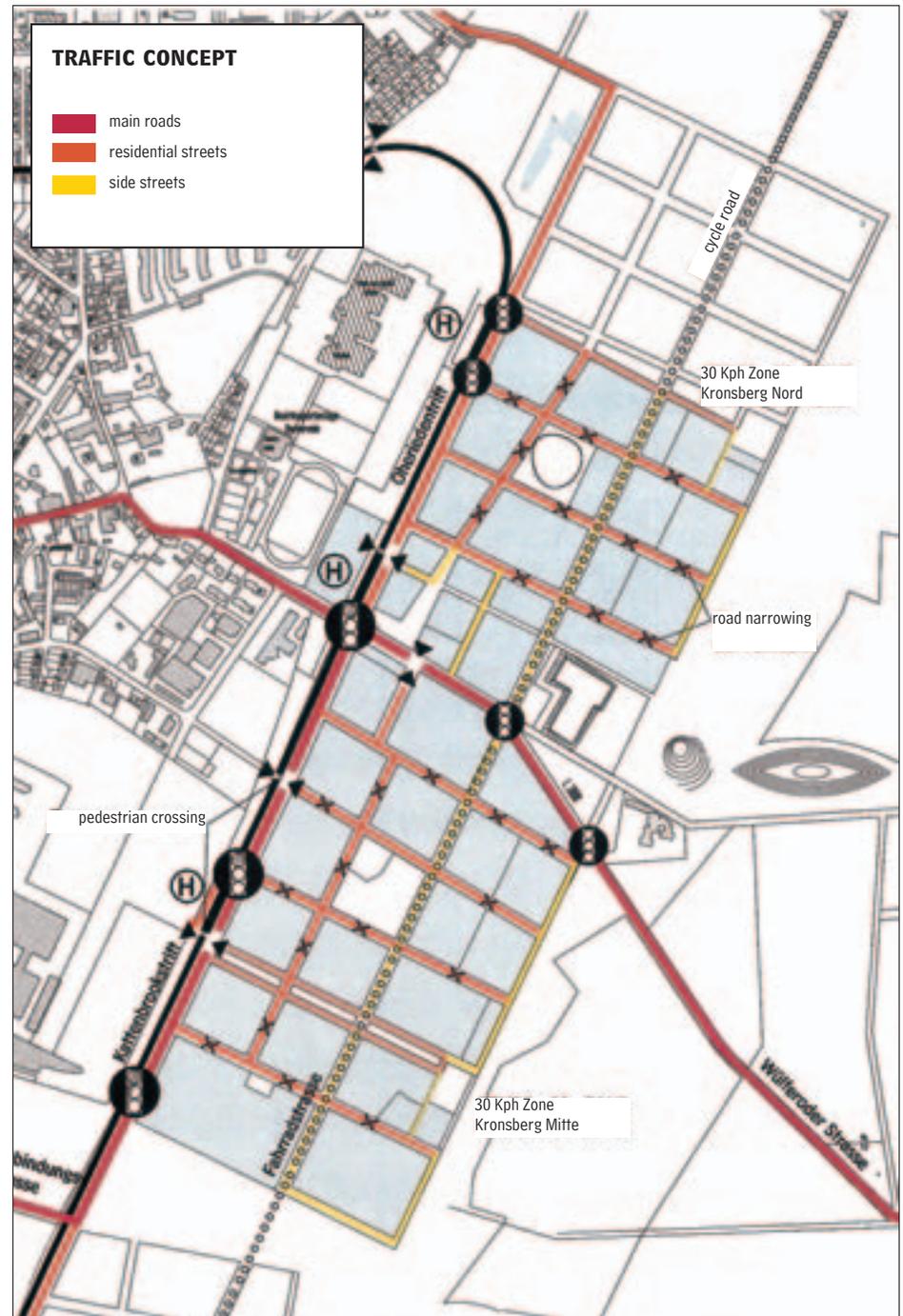


Because of the short distances (about 550 metres) between stops each is within easy walking distance, on average 300 metres. A bus route provides other cross-connections.

The residential area lies on one side of a new main access road, from whence streets run uphill to the houses. Nearly every house can be reached by car, but through traffic is not possible.

The sections of the district are linked by a main cycleway, specially marked by the road surface, to which all homes are safely connected.

The public infrastructure is decentralised, so most facilities are within easy walking distance and using the car makes no sense. Although the new district has an excellent public transport network



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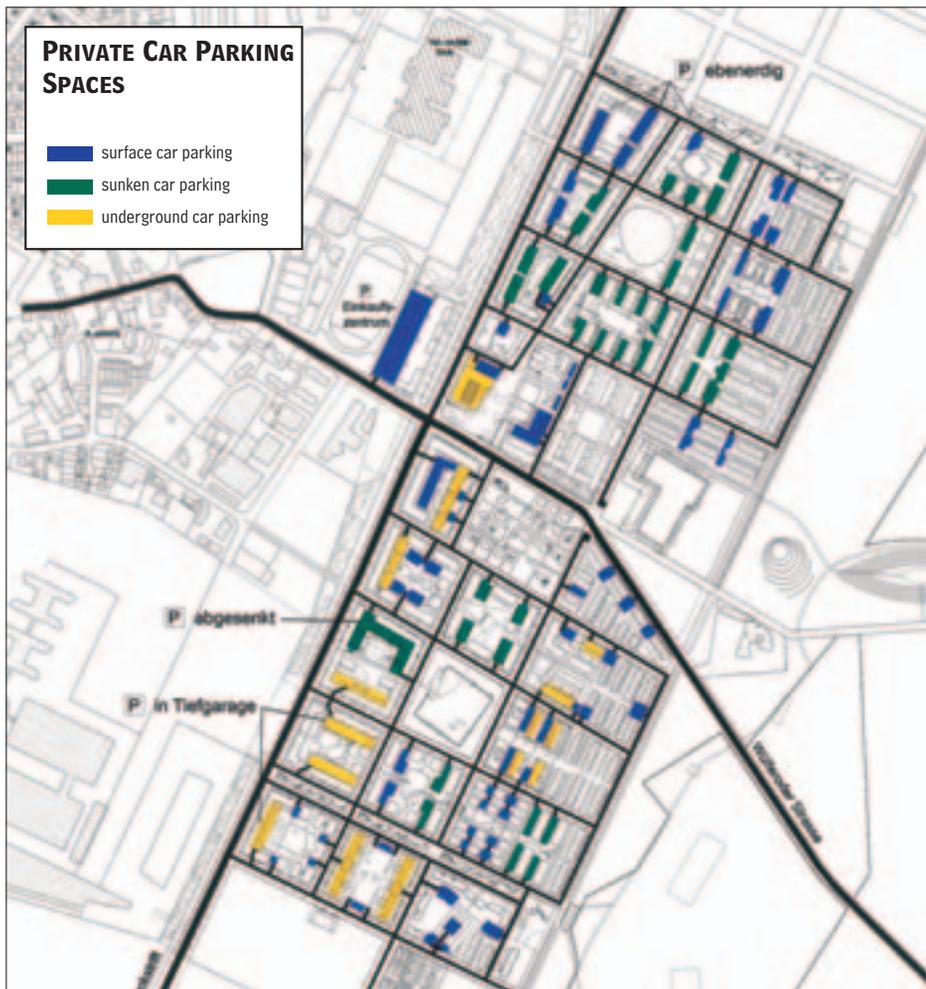
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the building regulations insist on traffic calming measures. Apart from the usual bylaws, on Kronsberg only 80 % of the required parking spaces can be located on private property. In compensation, additional spaces were built beside the public streets. This saves on paved areas, and permits multiple use of parking spaces through the day.



Cycle road



Literature

- Weltausstellung und Stadtteil Kronsberg, Der städtebauliche Rahmen für die EXPO 2000 in Hannover, dtsh./engl., LHH Baudezernat, Planungsgruppe Weltausstellung, 1999
- Stadtteil Kronsberg, Wohnen im 21. Jahrhundert, LHH Baudezernat, Planungsgruppe Weltausstellung, Mai 1998

2.12 FINANCIAL SUPPORT AND CALCULATIONS

Construction of the EXPO grounds was supervised and supported by the City of Hannover through the 'Hannoverprogramm' set up in 1994 - an action programme to set priorities in securing the economic location factors of the city and in sustainable urban development. It was comprised of many and varied single projects serving Hannover's preparations for hosting the World Exposition – projects to equip the city with the necessary transport and other infrastructures, to make the city centre more attractive and to improve the social and ecological conditions of urban life. Development of the completely new Kronsberg city district close to the World Exposition grounds, which was also to provide accommodation for EXPO personnel, was part of this programme.

Execution of these projects relied to a great extent on third party finance, and for the first time a bond issue was made to finance civic measures. The municipality's share of the total investment volume of around 2.2 thousand million € could thus be limited to the bond issue of c. 77,000 €.

For Kronsberg an agreement was arrived at between the supervisory board, the City Council and City Administration that the 'planning benefit' from redesignation of land as building plots should flow into a ring-fenced finance model and thus be directly available for infrastructure in the new development area. Through

the land redistribution regulations and the urban construction contracts the private sector landowners were also obliged to contribute to creation of the local infrastructure.

In this way most of the necessary funding was made available. In the first construction phase the public services infrastructure for around 3,000 homes required around 61 million €. Housing construction by the private sector was publicly subsidised with around 150 million € made available through preferential loans and subsidies.

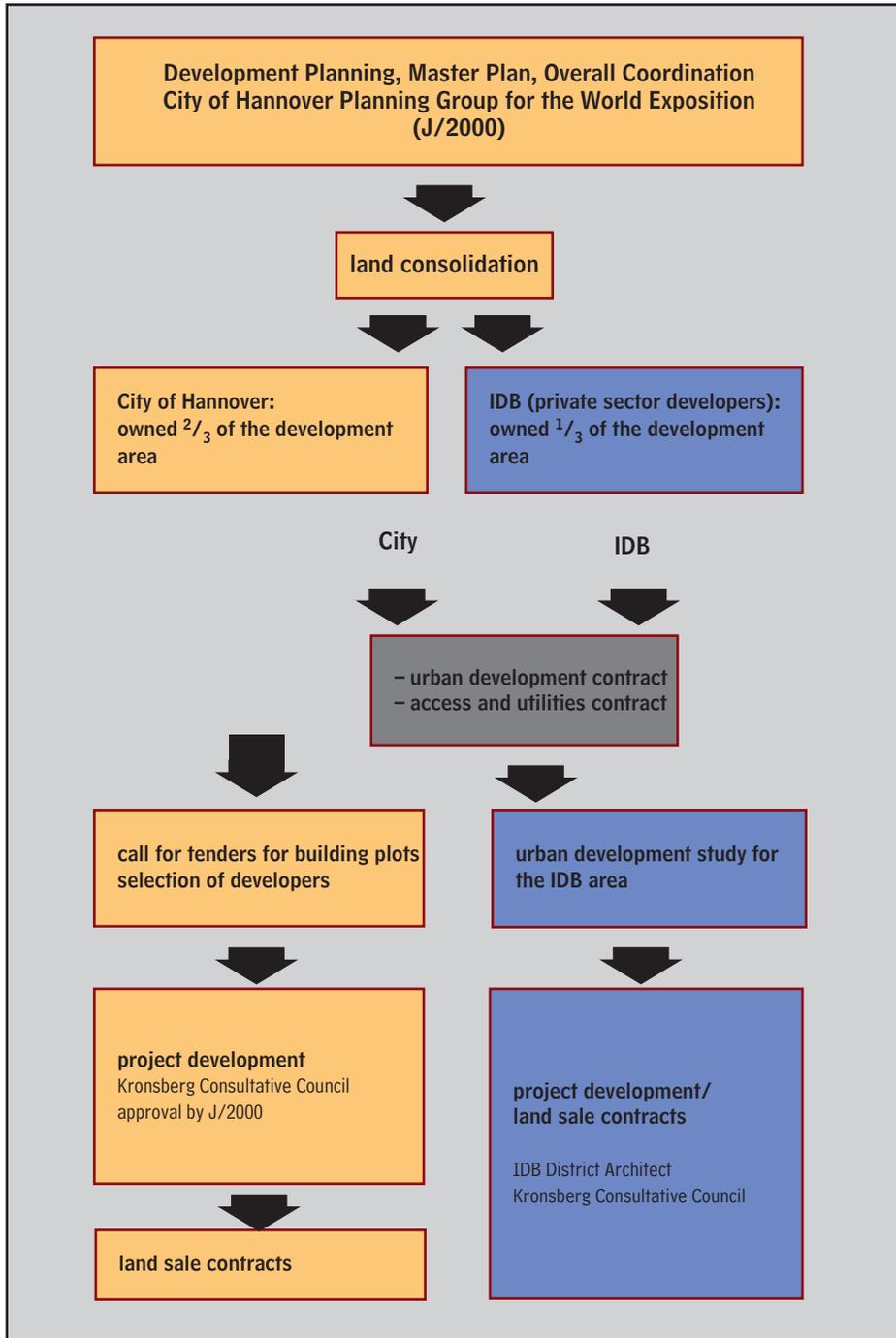
In total, for the first construction phase from 1997 to 2000, more than 500 million € were invested by the private and public sectors.

A specialist office was established for financial monitoring of projects.

Additionally, 300 million € was invested in the tram route to the EXPO grounds and the Kronsberg settlement, and for commercial premises in the new city district, c. 130 million € on a new building for dvg and c. 45 million € for the LBS building were invested.

1.5 million € could be also acquired from private-sector sponsors for the sports and recreation park in the Kronsberg countryside.

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2.13 THE PLANNING PROCESS

An integrated planning process formulated long term urban development goals and devised implementation strategies.

For the southeast of Hannover this meant:

- creation of a large-scale landscape enhancement concept for Kronsberg where the interests of recreation, nature conservation and agriculture impinged upon each other
- modernisation of the trade fair grounds
- introduction of a rapid public transit network for the south-east of Hannover with a new tramline and introduction of a suburban train system for the region
- development of a new urban district for up to 15,000 people with the necessary infrastructure as an integral part of developing further commercial areas in the vicinity of the trade fair grounds.

The entire development concept was devised according to the vision of sustainable development through which the World Exposition motto 'Humankind – Nature – Technology' was also applied to town planning.

One of the main implementation strategies was to use this concept not only for the EXPO 2000, but to use the World Exposition as the driving force of urban development.

From the very start, all relevant disciplines were brought together in an integrated planning process. The traditional areas of responsibility within the city administration were retained: overall responsibility for planning and implementation lay with the World Exposition Planning Group in the City Construction Directorate, while the Environmental Planning Group reporting to the Environment Directorate was responsible for ecological matters. Social planning was supervised by the Directorate of Health, Youth and Social Services.

Additionally, an advisory council was constituted of respected experts in urban development, architecture, open space and landscape, housing and social issues to monitor and guide both practical design and construction and the process of planning and realisation. This council had an advisory capacity, while the conven-

tional division of responsibilities was retained within the city administration.

The main thematic emphasis was a formulation of standards to build a sustainable, future-orientated urban development with strong emphases on the quality of urban development, environment and social planning.

The brief for the 1992 urban and landscape planning competition in 1992 was to devise concepts for long term settlement development. In a further urban construction design competition in 1993 the structure of the residential district was developed as the basis of construction plans.

In a competition for investors in 1995–6, building contractors were sought who were willing to put the numerous and little-tested standards into practice. The individual investors were included in a cooperative planning process. That meant that all stakeholders, from clients and their architects to diverse representatives of the administration, discussed the issues together and gave their joint response. This permanent communication process was monitored and guided by the Kronsberg Advisory Council, which made it possible to set up general principles for the project development.

Further components of the integrated planning and construction process were:

- citizens participation through the appointment of a planning advocate as contact person for all citizens, and wide-ranging public relations work
- appointment of a district coordinator, also a contact for local people
- establishment of KUKA (Kronsberg Environmental Liaison Agency) to support the entire process.

Literature

- Hannover Kronsberg, Realisierung einer nachhaltigen Planung, LHH und KUKA, 3. überarbeitete Auflage 05/2000
- Modell Kronsberg: Nachhaltiges Bauen für die Zukunft / Sustainable Building for the Future, LHH September 2000

URBAN CONSTRUCTION	SOCIO-CULTURAL AMENITIES	ENVIRONMENT
COMPLEX USE STRUCTURE residential, commercial, recreation, agriculture, transport alignment to the tram route	BALANCED SOCIAL MIX	ECOLOGICAL STANDARDS
SPACE-SAVING CONSTRUCTION high density development architectural variety compact building structures	DISTRICT CENTRE arts and community centre Protestant church centre shops	ENERGY energy efficiency optimisation district heating from decentral CHPs energy efficiency optimisation electricity saving concept
HIGH STANDARD OF ACCOMMODATION good quality, good value housing comprehensive infrastructure plenty of varied green and open space	SOCIAL INFRASTRUCTURE play house children's day centres primary school and school centre FOKUS housing project Habitat international housing project communal use areas	innovative technology solar-powered district heating passive houses microclimate zone wind turbine generators photovoltaic installations
OPEN SPACE QUALITY district square, neighbourhood parks avenue-like streets generously-proportioned inner courts countryside park corridors	NUTRITION market Herrmannsdorfer Landwerkstätten organic farm	WATER rainwater concept drinking water economies
TRANSPORT tramline traffic calming close-knit path network cycle road parking space concept		WASTE environmentally responsible building materials construction waste concept domestic and commercial waste concept
BALANCED SOCIAL MIX broad range of housing construction subsidies mixture of housing types family houses creation of neighbourhoods		SOIL soil management decontamination
COOPERATIVE PLANNING PROCEDURE		LANDSCAPE landscape park ecological agriculture
		ENVIRONMENTAL COMMUNICATIONS KUKA

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3. Technical Planning and Construction



Certification as EXPO 2000 project

3.1 ECOLOGICAL OPTIMISATION AT KRONSBERG

The overriding objective in developing the new district was optimal sustainable planning and construction at all levels, applying the latest knowledge and expertise on ecological building and habitation in the spirit of Agenda 21. The ambitious ecological objectives were set out in an appropriate framework through the land-saving development concept, the environmentally friendly traffic concept, high quality open space planning and the proximity of housing and workplaces.

Along with the overall ecological concept, building planning and construction of all homes and commercial buildings, and the planning and laying out of open space, were also required to meet exceptionally high ecological standards. For this reason, a special 'Kronsberg Standard' was devised to apply across the district to all buildings and open spaces, setting stringent and legally binding

ecological conditions within the development plan, the single land sale contracts and other relevant regulations and bylaws.

The 'Ecological Optimisation at Kronsberg' project was recognised as one of the City of Hannover's decentral EXPO 2000 projects. Planning and construction priorities were environmentally compatible energy provision systems combined with ecological building methods and sparing use of natural resources. The project was subdivided by ecological theme into various concepts:

- energy efficiency optimisation
- rainwater concept
- waste concept
- soil management
- environmental communications

Concurrently with Ecological Optimisation, the Kronsberg district was an important feature of two other City of Hannover EXPO projects:

City as Garden City as Social Habitat

Many of the ambitious objectives of these two projects were pursued in the planning and construction of the Kronsberg district and in the enhancement and landscaping of the surrounding countryside.

KRONSBURG GENERAL DEVELOPMENT PLAN

- 1 rainwater retention basin
- 2 Kronsberg primary school with water concept and photovoltaic installation
- 3 tram line
- 4 border avenue
- 5 northern hillside avenue
- 6 KUKA
- 7 children's day centre 1 with playhouse
- 8 decentral CHP plant in cellar
- 9 northern neighbourhood park
- 10 special terraced house programme
- 11 atrium houses
- 12 passive houses
- 13 church centre
- 14 'KroKuS' arts and community centre with photovoltaic installation
- 15 health centre
- 16 shopping centre
- 17 northern viewpoint hill
- 18 cycle road
- 19 semi-natural rainwater retention at the foot of the hill
- 20 'Habitat' – international housing project
- 21 central neighbourhood park with children's day centre 2
- 22 rainwater management in the inner court
- 23 microclimate zone
- 24 central hillside avenue
- 25 solar energy storage tank & playground for children's day centre 3
- 26 'Solarcity'
- 27 children's day centre 3
- 28 energy centre (decentral CHP plant)
- 29 LBS system houses
- 30 comprehensive school with photovoltaic installation
- 31 LBS
- 32 dvg
- 33 sports and games park
- H tram stop



SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

3. Technical Planning and Construction

KRONSBURG ENERGY CONCEPT

- ① photovoltaic installation
- ② decentral CHP
- ③ passive houses
- ④ microclimate zone
- ⑤ solar-powered district heating
- ⑥ energy centre (CHP)
- ⊗ wind turbine generator



3.2 ENERGY CONCEPT

General

In devising the energy concept for Kronsberg, from the outset it was not the spectacular highlights which were emphasised but the development of generally applicable energy efficiency measures that would be acceptable to developers and residents, and proposals were to be implemented that would also be possible without subsidies.

The framework conditions for devising the Kronsberg concept were:

- the City of Hannover's energy policy aims
- the Hannover Energy Concept
- the Hannover Climate Protection Programme

On 26 November 1992 Hannover City Council passed the City's energy policy aims. The objectives relating to the Kronsberg were:

- In all areas, priority was to be given to energy saving over other aims.
- Rational exploitation of primary energy was to be promoted through expansion of Combined Heat and Power systems.
- Renewable energy sources were to be employed more than had hitherto been the case.

According to the 'Hannover Energy Concept' principle recommendations for the Kronsberg district were:

- For all new buildings, the target efficiency should be a heating energy demand of 50 kWh/m² and year, to be achieved mainly through improved insulation in external building components.
- District heating or waste heat utilisation should have priority.
- Heating should be centrally provided through the heating system.
- Washing machines and dishwashers should be connected to the hot water system by short pipe runs.
- No electrical heating systems should be installed.

In the Climate Protection Programme, which during the planning period existed as an agreed proposal from the city administration, the carbon dioxide (CO₂) potential reductions in Hannover through to 2005 were itemised. The proposals foresaw:

- 10,000 tonnes of CO₂ saved through Low Energy House construction methods for 15,000 new homes (around half of this target was met by construction on Kronsberg)
- expansion of decentral CHP district heating provision to 30 MWe by the year 2000, saving 35,000 tonnes of CO₂ and
- use of renewable energy sources for electricity and heat generation, saving 30,000 tonnes of CO₂.



Registration certificate as EXPO 2000 project

Concept and Responsibilities

The Kronsberg Energy Concept was drawn up and coordinated by a steering group comprising employees of the city energy utility (Stadtwerke Hannover AG), the City Planning Directorate and the City Environment Directorate.

For its part, the City commissioned a local consultancy to devise an aims-oriented systematic collation and evaluation of options for action. Guiding criteria were climate impact and economic viability, with supplementary criteria addressing such issues as social compatibility, future flexibility and effect on the employment market. Further, the consultancy advised the City on implementing the desired concept through conditions attached to construction plans, land sale contracts and other instruments.

The same consultancy was commissioned to look at possible demand side reductions in energy consumption, for which many different construction standards were analysed.

For its part, Stadtwerke Hannover AG took the role of assessor in studying various energy provision options, comparing centralised and decentralised provision variants on the primary criteria of CO₂ reduction and economic viability.

Aims

The energy concept target was to reduce carbon dioxide emissions by 60% compared to normal levels as based on current national construction standards, the 1995 insulation regulations and gas-fired decentralised energy provision.

The second important objective was to achieve this 60% reduction at almost no extra cost and thus to meet social compatibility criteria.

Within the project, however, the City Council and administration sought to achieve even further reductions in CO₂ emissions of up to 80%; the additional 20% was to be achieved through use of wind power on Kronsberg and implementation of exceptionally innovative ecological and technical solutions. Assessments made clear that they could only be realised with subsidies.

SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

3. Technical Planning and Construction

Results and Incorporation in the Planning Process

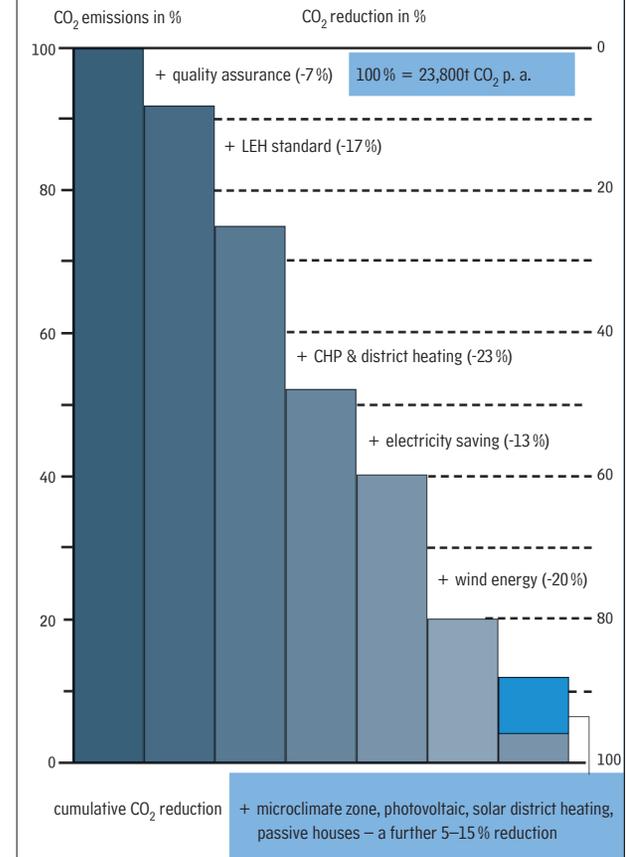
From the assessments mentioned above of energy demand and provision on Kronsberg, the best scenario was a combination of:

- Low Energy House construction methods with quality assurance monitoring and skilling and qualification schemes
- district heating provision from decentralised Combined Heat and Power (CHP) plants
- electricity saving programme

According to the assessors these components would ensure a 60% reduction in CO₂ emissions. From the start, however, it was clear that the construction industry would not apply the energy concept of its own accord; it was necessary to devise new legal and regulatory instruments to make sure that these components would be purposefully incorporated.

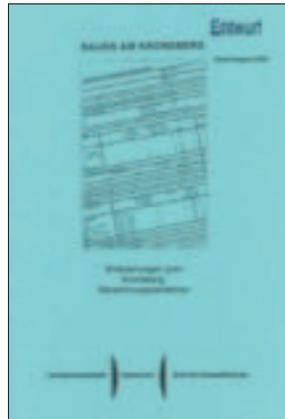
To implement the objectives and measures of the energy concept in the wider planning process, then, Hannover City Council decided to use the land sale contracts, development plan, district heating bylaw and subsidy guidelines for social housing. These instruments will be described in more detail in the following chapters.

REDUCTION OF CO₂ EMISSIONS AT KRONSBERG



Literature

- Energiekonzept Kronsberg –Gutachten 4, Maßnahmen und Instrumente, LHH November 1994
- Informationsdrucksache-Nr. 1328/94 Energiekonzept Kronsberg, LHH 1994
- Modell Kronsberg: Nachhaltiges Bauen für die Zukunft / Sustainable Building for the Future, Hannover September 2000



Explanation of the Kronsberg
calculation procedure

LOW ENERGY HOUSES

Concept and Responsibilities

In late 1994 the Kronsberg Energy Concept was complete as a report to the City Council, having been agreed within the city administration. The next matter was to apply the single components. Coordination within the administration passed to the planning group for the World Exposition, 'Arbeitsgruppe Umweltplanung Weltausstellung', at the City Environment Directorate.

The land sale contracts were the legal basis for construction of buildings on Kronsberg to the Low Energy House (LEH) standard. To monitor and prove that these standards had been met, the Kronsberg calculation procedure (Kronsberg-Berechnungsverfahren) form was devised, to be submitted along with the planning permission application and public announcement.

To prevent delays in processing planning permission applications and land sale contracts, and to assist property developers in preparing documents, the following steps were taken:

- preparation of a checklist, 'Bauen am Kronsberg', itemising the necessary documentation for land sale contract and planning application, and listing contacts within the city administration,
- an extensive programme of workshops and range of brochures

Building on Kronsberg					6
Form to ascertain Low Energy Construction					
Property			Processed by		
Client			Inspector		
Details of Building					
EBF	energy demand area (living area to be heated)				m ²
V	volume = EBF x ceiling height				m ³
n	air exchange rate	natural ventilation ventilation plant heat recovery	0.5 0.3 0.1 + 0.2 (L-eta)		l/h
Heat Loss					
building component	area (external dimensions) (m ²)	k-value DIN 4108 (W/ m ² K)	Gt (kWh/a)	loss (kWh/a)	
walls	x	x	87	=	
windows	x	x	87	=	
roof	x	x	87	=	
floor area	x	x	44	=	
ceiling to external surface	x	x	87	=	
QT	sum of conducted heat loss				kWh/a
QL	air exchange rate n (l/h)	air volume V m ³	c x Gt (Wh/a)/(m ³ xl/h)	loss (kWh/a)	kWh/a
QL	x	x	29	=	kWh/a
QV	sum of heat losses = QT + QL			=	kWh/a
Heat Gain					
window orientation	r	window area raw dimensions m ²	g value	solar radiation (kWh/(m ² a))	gain (kWh/a)
horizontal	0,56	x	x	350	=
south	0,42	x 0,9 x	x	335	=
southeast / southwest	0,42	x 0,9 x	x	252	=
east / west	0,42	x 0,9 x	x	190	=
northeast / northwest	0,42	x 0,9 x	x	123	=
north	0,42	x 0,9 x	x	80	=
QS	sum of solar gains (kWh/a)			=	
QL	interior heat sources = EBF x 10 kWh/(m ² a)			=	
QF	sum of free heat = QS + QL (kWh/a)			=	
f	gain factor from free heat = 1 - 0,3 x QF / QL			=	
QG	heat gain = f x QF			=	kWh/a
QH	heating energy needs = QV - QG			=	kWh/a
gH	specific heating energy need (energy index for heating) = QH / EBF			=	(kWh/(m ² a))
place, date					signature
					endorsement
					The figures match these in the planning application.

Form to ascertain the heating energy index using the Kronsberg calculation procedure

SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

3. Technical Planning and Construction

All clients and construction companies were obliged through the land sale contracts (s. Appendix 1) or urban construction contracts to carry out construction work to the Kronsberg LEH standard. Insulation standards were fixed as:

- heating energy index of 50 kWh/(m²*a) as target value
- this figure to be exceeded by a maximum 10% (limit value)
- the calculation method for the heating energy index defined
- monitoring by qualified engineers
- penalty payments of 5 €/m² for exceeding the limit value
- provision of subsidies by the local authority.

The insulation certificate was to be presented after a standardised calculation on both printed form and as EXCEL datafile. The calculation method was based on the 'Leitfaden energiebewusste Gebäudeplanung' (guidelines for energy-conscious building planning) from the State of Hesse.

Aims

The primary objective was to prove that the LEH standard was an economical approach to reducing energy demand in new buildings to a minimum, responding to the global sustainability imperative and simultaneously making the homes more comfortable. The approach was also to be demonstrably economical as, for the sake of simplicity, it addressed the building components that were in any case needed in a building: building envelope, windows and ventilation system. This should also guarantee technical feasibility – no LEH multiple occupation buildings and settlements of comparable size and high standards had until then been built.

Of the projected 60% reduction in CO₂ emissions, 17% should be achieved with the LEH standard and 7% through quality assurance monitoring.

Once the energy concept had been agreed, planning assistance on the various issues of LEH construction methods had to be set up – property developers should be provided with information and basic know-how, and encouraged by the city to take on these construction challenges with these, at the time, little-known standards. The objective was thus to collect and prepare the basic knowledge to help developers and planners, most of them unfamiliar with the new construction tasks, manage their new responsibilities.



Insulation during construction

Standard publications were commissioned by the City and distributed free to developers and planners. The 'Bauen am Kronsberg, Hinweise zur Realisierung des Niedrigenergiehaus-Standards' series comprised handbooks on:

- insulation and airtightness (May 1995)
- ventilation (Sept. 1996)
- heating technologies (Feb.1998).

Additionally, workshops were held on current or upcoming issues. Between October 1995 and August 1996 there were 4 events for potential clients, architects and planners on:



Insulation around a window



Cavity insulation

- Low Energy House construction methods, erection and technology
- low-price Low Energy Houses
- explanation of the Kronsberg calculation method, (s. Appendix 2).

Results and Incorporation in the Planning Process

All residential buildings in the Kronsberg district were built as Low Energy Houses. Each building requires a proven maximum heating energy of 55 kWh per m² and year, checked by the quality assurance monitoring programme. For non-residential buildings it was permissible to present an insulation certificate according to the 1995 insulation regulations in force at that time minus 30%. For the primary school, the children's day centres, the shopping centre and the district arts and community centre this was the method chosen. In these cases, too, adherence to the limit values could be guaranteed through a quality assurance monitoring programme.

Literature

- Hinweis zur Realisierung des Anforderungsprofils NEH Standard – Wärmedämm- und Dichtheitskonzept – 1995
- Berichtsband: Niedrigenergiehäuser-Werkstätten, Oktober/November 1995
- Berichtsband: 3. Niedrigenergiehaus-Werkstatt, Kostengünstige Niedrigenergiehäuser, Juni 1996
- Berichtsband: 4. Niedrigenergiehaus-Werkstatt, Berechnungsverfahren zum Nachweis der Niedrigenergie-Bauweise, August 1996
- Hinweise zur Realisierung des NEH-Standards – Lüftungskonzept –, 1996
- Edition: Bauen am Kronsberg, Erläuterung zum Kronsberg-Berechnungsverfahren, LHH August 2002
- Städtebaulicher Vertrag zwischen der Landeshauptstadt Hannover und der Immobilien Development und Beteiligungsgesellschaft Niedersachsen mbH, Hannover 1997
- Modell Kronsberg: Nachhaltiges Bauen für die Zukunft / Sustainable Building for the Future, Hannover September 2000
- Grundstückskaufvertrag der Landeshauptstadt Hannover, 1997. (s. Appendix 1)

SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

3. Technical Planning and Construction

QUALITY ASSURANCE

Concept and Responsibilities

The City of Hannover local authority supported the erection of buildings on Kronsberg that met the requirements of the Low Energy House standard through a special grants programme compensating for the extra costs incurred by quality assurance monitoring to achieve these standards.

In the land sale contracts the City committed itself to applying for private and public subsidies for energy saving measures in the Kronsberg development including quality assurance monitoring. After acquiring funds from EXPO 2000 Hannover GmbH and the European Commission, the City administration prepared the subsidy guidelines for quality assurance of LEH buildings on Kronsberg ('Förderrichtlinie zur Qualitätssicherung von Niedrigenergiegebäuden am Kronsberg' – in June 1997, which were finally approved by the City Council on 15 January 1998 (Appendix 3).

The subsidies are towards:

- extra costs for quality assurance monitoring to achieve the LEH standard
- costs of extra hot water connections for washing machines and dishwashers.

Quality assurance measures were partly subsidised up to a maximum of half the actual expense, but not exceeding 5 €/m² of living and usable space.

The attachments to the guidelines set out the obligations of the recipient (planner or property developer) to the City of Hannover. These included:

- proof of the heating energy index
- meeting airtightness requirements
- submission of defined planning documentation
- inspection and checking of work

Implementation of the subsidy guidelines was in the hands of the Environmental Planning Group for the World Exposition. To facilitate qualified, intensive and timely supervision and inspection of the construction sites, seven suitable independent engineering offices from Hannover and the region were accredited. Led by the City, the joint quality assurance workgroup created a forum for



the exchange of experience, aiming to treat all construction projects equally, also with regard to costs, economic viability and workload. The group set common guidelines on:

- inspection methods and procedures
- details of the calculation method
- evaluation of construction details.

Aims

The commitment to quality assurance was included in the land sale contracts. This incorporated the following objectives:

- guarantee of the Low Energy House standard
- minimisation of thermal bridges and airtight construction to avoid heat loss and damage to the fabric
- comfortable accommodation
- correlation of planning and construction
- quality guarantees for the owner and user.

The quality assurance scheme was applied as a five-stage process throughout the construction period:

- stage 1: checking adherence to the required energy index
- stage 2: checking detail planning
- stage 3: checking work on site and documentation
- stage 4: measuring adherence to limit values for airtightness
- stage 5: certification (s. Appendix 4)

Results and Incorporation in the Planning Process

It was possible to overcome construction companies' initial resistance to the quality assurance programme through intense discussions, special events and financial incentives by the City. Bringing in the quality assurance inspectors, who had many years

of experience in this field, meant that thermal bridges could be avoided from the early design stage and the Kronsberg insulation standard guaranteed. Intensive supervision on site not only stopped 'bodging on the job' but also gave craftspeople new skills. Participation by KUKA in the quality assurance workgroup meant that its new knowledge could flow directly into the skilling and qualification measures run by the Kronsberg Environmental Liaison Agency (KUKA). For instance, site meetings could be organised at short notice at which architect, planner, foreman and leading craftspeople could discuss a current problem with an external mediator and devise a solution.

The quality assurance monitoring concluded with a blower door test that in the vast majority of cases confirmed the high quality of the work, while occasional minor faults were quickly rectified. Differences of opinion could be expressed and resolved in the quality assurance workgroup; such a body proved to be indispensable for a project of such magnitude involving so many different stakeholders.

The measures carried out under the quality assurance programme showed that the requirements of Hannover City Council were being met. Evaluation by the engineering bureaux of a large number of building projects revealed exploitation of potential energy savings of 4750 MWh/a – enough to heat about 400 detached houses. These findings were derived from comparing the Kronsberg Standard with the current standard for conventional new constructions according to the 1995 insulation regulations.

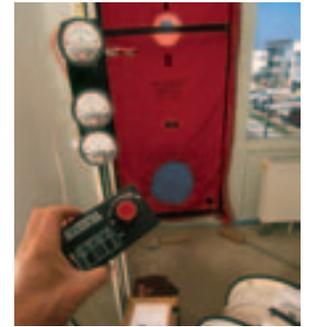
Complementing the project, in September 1999 a very successful specialist conference on Low Energy Buildings – quality assurance and skilling/qualification measures was held. The conference aim was to present:

- concepts for quality assurance and skilling/qualification
- transferable planning instruments
- the importance of stakeholder and project networking for the success of process-based monitoring of quality assurance and skilling/qualification.

Around 80 practitioners attended the event. It became clear that quality assurance as practised on Kronsberg could be transferred to other construction projects.



Skilling and qualification on site



Blower door test

The contractually defined quality assurance and simultaneous skilling and qualification measures – as implemented in exemplary fashion on Kronsberg – set a new standard for residential development. The heating energy saving potential, achieved through quality assurance, is economically viable without subsidies. To this is added the potential for CO₂ reduction and reduction of damage to buildings such as mould caused by dampness. Actual additional costs, depending on the size, individuality and profile of the construction projects, were between 4 and 8 €/m².



Literature

- Städtebaulicher Vertrag zwischen der Landeshauptstadt Hannover und der Immobilien Development und Beteiligungsgesellschaft Niedersachsen mbH, Hannover 1997
- Grundstückskaufvertrag der LHH, 1997. (s. Anhang 1)
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- Edition Bauen am Kronsberg: 3.2 Richtlinien zur Förderung der QS von NEH, 1998; Mit Antragsformularen, (s. Anhang 3)
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SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

3. Technical Planning and Construction



A selection of low-energy light bulbs

ELECTRICITY SAVING PROGRAMME

Concept and Responsibilities

Kronsberg property developers received a grant of 25 € per hot water connection for washing machines and dishwashers. This was laid down in the 'Richtlinie zur Förderung der Qualitätssicherung von Niedrigenergiegebäuden' (guidelines for promotion of quality assurance in Low Energy Buildings – see previous section).

Because installing and running energy-saving appliances was voluntary, it was important to offer additional incentives. From EXPO Hannover GmbH funding, then, an energy saving programme to subsidise the use of low-energy appliances by Kronsberg tenants and owner-occupiers was set up. The energy saving programme was passed by the City Council in September 1998 (council resolution No. 2488/98) to run until June 2001.

Related to the skilling and qualification measures on Kronsberg, the electricity saving programme had three components:

- free distribution of energy-saving light bulbs and water-saving taps – each household was entitled to five low-energy bulbs and two water aeration attachments for taps. Residents could choose from a range of 30 light bulb models differing in size, form and function.
- grants for the purchase of electricity-saving appliances – purchase of particularly thrifty washing machines and dishwashers, refrigerators and freezers attracted a grant of 50 € per appliance.
- advice in person or by telephone on electricity saving habits.

Local people were made aware of the grants programme by leaflets distributed all over the district, notices in the entrance lobbies, and announcements in the 'Kronsberg life' and 'Kronsberg aktuell' magazines.

Kronsberg Environmental Liaison Agency (KUKA) was charged with implementing the grants programme, and approached the residents directly. This ensured that:

- support and advice in making grant application contributed to the success of the programme and
- other information e.g., about living in a Low Energy House, reached the residents, and synergy effects with other subsidy programmes could be exploited.

Aims

Of the planned 60% reduction in CO₂ emissions, 13% was to be achieved through electricity saving.

Results and Incorporation in the Planning Process

Personal advice sessions happened both in the KUKA offices and, on request, in the apartments. The subjects of these counselling sessions were mainly:

- appliance checks with an electricity meter, producing a cost-benefit analysis that showed how much electricity could be saved by buying new appliances.

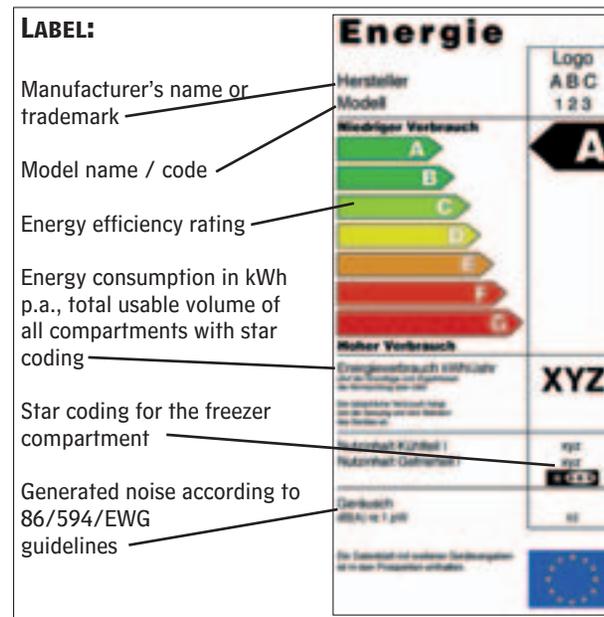
- analysis of electricity consumption with a consumption log-book. As part of the skilling and qualification measures for Kronsberg residents KUKA produced a householders file, with information such as 'How to use a Low Energy House'. The file included a table where householders could note their current electricity consumption. The advisor's task was to make residents aware of the usefulness of this monitoring and show them how to use the tables.
- immediate installation of low-energy lamps and water-saving tap attachments
- investigation of further possible energy savings in the apartment e.g. consumption of standby function, settings for the heating and ventilation systems
- help with filling out the grant application.

Within the electricity saving programme grants were made towards the purchase of:

- 77 washing machines
- 106 dishwashers
- 56 refrigerators
- 66 fridge-freezers.

In the course of the subsidy programme, KUKA distributed 5,615 low energy light bulbs.

Moreover, an evaluation found that around 60% of Kronsberg apartments have hot water connections for washing machines and around 75% for dishwashers. How many are actually used cannot be determined.



An EU energy consumption label

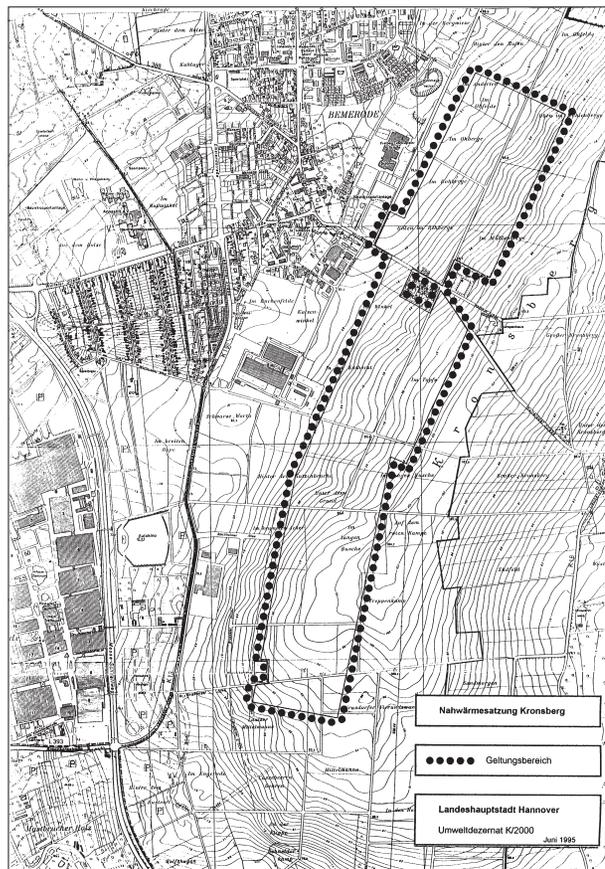
Literature

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- Modell Kronsberg: Nachhaltiges Bauen für die Zukunft / Sustainable Building for the Future, Hannover September 2000
- Beschlussdrucksache-Nr. 2237/2000 Energieeinsparprogramm Kronsberg, 2000
- CO₂-Bilanz 2000, INFU, November 2001
- Evaluation der Kronsberg-Umweltkommunikations-Agentur, INFU, Universität Lüneburg, 2001

SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

3. Technical Planning and Construction

Area covered by the district heating by-law



DISTRICT HEATING PROVISION

Concept and Responsibilities

The basis of district heating provision on Kronsberg was a series of studies that compared energy provision variants in terms of cost- and environmental effectiveness. In this the assessors (led by the Niedersächsische Energieagentur and in cooperation with the Stadtwerke Hannover energy utility) assumed a mixture of block development, pavilion constructions and terraced houses to present 19 possible models for heating and hot water provision, taking into account three different standards of building insulation. Among the centralised and decentralised study variants were:

- conventional single-source forms of heating technology such as condensation boilers, gas-motor decentralised CHP or fuel cell CHP
- mixed forms with additional solar generation or wind and photovoltaic use
- special forms with heating plants using wood chip burners or biomass.

To collate important basis information and emission data for the entire project chain, the Stadtwerke Hannover AG city utility used the internationally recognised GEMIS calculation programme. It became clear that centralised heating provision via extensive district heating networks with heating and electricity generation from gas-powered CHPs was the best variant.

To create the prerequisites to apply this concept, several legal instruments had to be applied. As early as 1995 Hannover City council passed a bylaw on district heating for the entire construction site (see appendix 5) that made connection to and use of the system compulsory in all buildings. Exemptions were and are only possible if the alternative is at least as ecologically efficient. Rights to lay piping and the locations of heating plants were therefore defined in the development plans and ensured by clauses in the land sale contracts or urban development plans (s. Appendix 1).

In 1996 the City of Hannover issued a European call for tender for the construction and running of the district heating system. Five roughly equal supply areas were offered, singly or in combinations. Seven offers were received (all from companies based in Germany)

and were checked and compared by the Energy Section and the Environmental Planning Group for the World Exposition (K/2000) at the City of Hannover Environmental Protection Division.

After negotiations following submission of tenders the city energy utility, Stadtwerke Hannover AG, was awarded the contract for four-fifths of the development areas and a medium-sized company, Getec mbH, that for the remaining fifth. Contractual negotiations set constant conditions and prices for 20 years, legally subject only to market-driven changes in oil prices.

Both Stadtwerke Hannover AG and Getec GmbH have produced a brochure (see 4.22, 4.23 and 4.24 on the CD-ROM) with a detailed description of their supply area. This documentation therefore lists only the most important technical data in tabular form:

A special feature on the roof of the Stadtwerke Hannover AG energy centre is a photovoltaic installation rated at 5 kW_p , 0.7 kW_p of which is used to orient it to the sun.

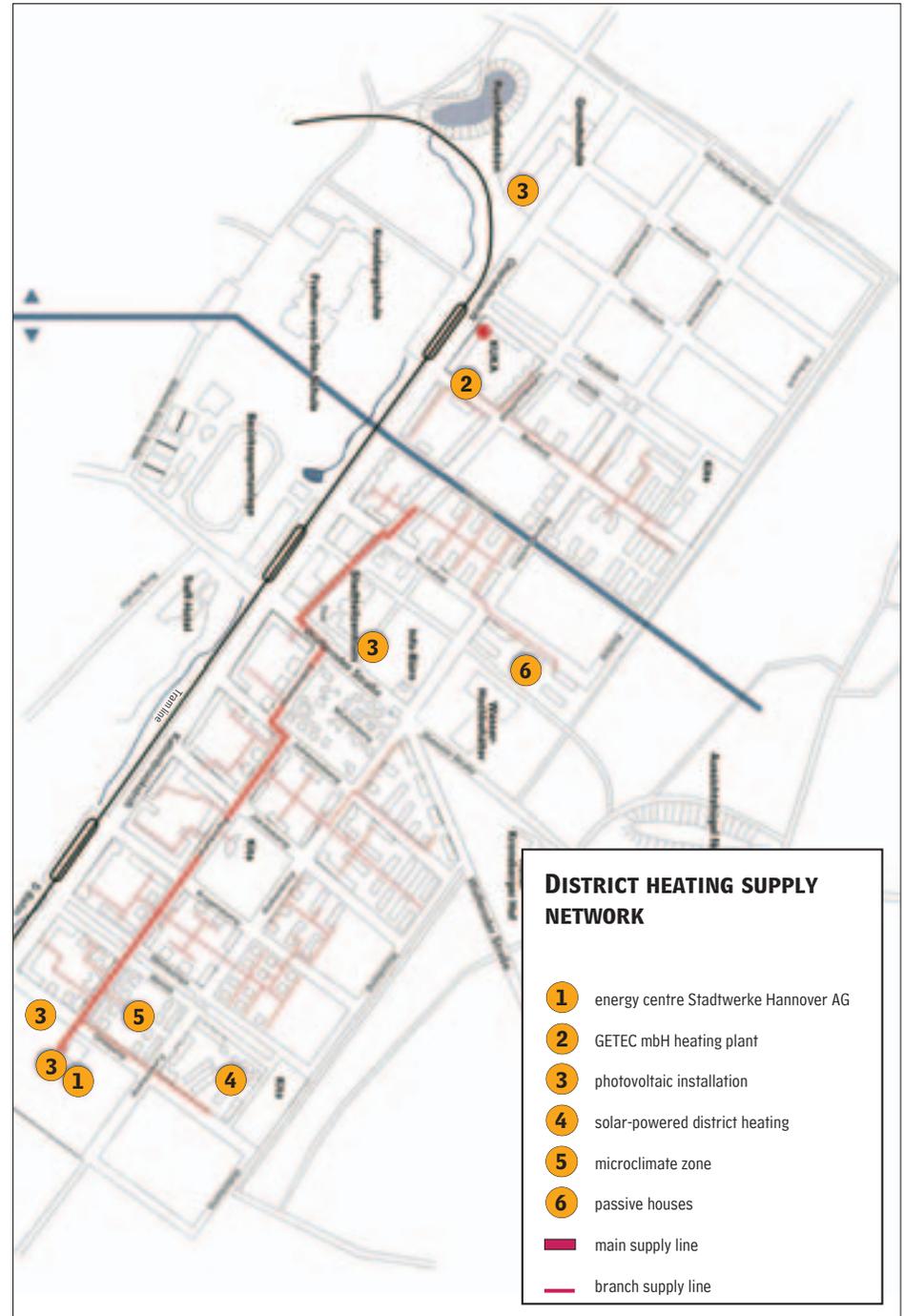
Aims

Of the 60% emission reduction on Kronsberg, 23 % was to be gained from the district heating system, making it the most important measure in the Kronsberg Energy Efficiency Optimisation programme (see the diagram in section 3.1.2).

Results and first Experiences of running the Systems

Demand from LEH apartments was expected to be comparatively low, and so the planning process looked for cost-saving concepts for laying the network: no inspection shafts, no permanent computer leakage monitoring and very shallow pipeline depths. To exploit the advantages of 'cut and cover' earth-covered pipelaying and to avoid hindering the concurrent laying of supply lines on the streets, network earthworks went through the 'green centre' of the block, laying lines across the inner courts.

Wild deviations in consumption in very different apartment types shows how difficult it is for many consumer to attain the low energy consumption made possible by LEH forms. Two points are obvious:



**SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS
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Stadtwerte Hannover AG energy centre

TECHNICAL INFORMATION ON THE KRONSBURG DISTRICT

parameter	Stadtwerte Hannover AG supply area	Getec mbH supply area
dwelling	2,300	742
infrastructure amenities	area of 240,000 m ²	kindergarten, primary school
network length	12 km	2.5 km
location of the heating plant	own property	cellar of a multiple-occupancy building
transfer stations in houses	100	26
ratings	10 – 400 kW	30 kW – 500 kW
heating plant technical data:		
boilers	2 x 5-MW gas fired boilers	2 x 1.65-MW gas fired condensation boilers
CHP module	1 unit delivering electricity: 1,165 kW _{el} thermal energy: 1,650 kW _{th}	2 units delivering electricity: 110 kW _{el} thermal energy: 220 kW _{th}
total electricity production	1,250 kW	220 kW
total heating production	11,700 kW	3,740 kW



Boilers



Decentral CHP module



GETEC mbH heating centre location



Decentral CHP plant in the cellar of an apartment house

- Apart from the dampness of the new buildings, which caused higher initial heating costs, one can identify a certain 'learning curve' in energy saving through comparing consumption figures.
- Consumption close to the target figure of 55 kWh/(m²a) for space heating was achieved by the third heating period (2000–1) at the latest and has already gone below this figure in some cases (s. Appendix 7).

From the point of view of the two energy utilities running the district heating networks, the relatively few technical problems in operations must be set against the relatively higher demand for consumer advice on alleged defects in the heating systems. It

becomes plain that LEH residents must be repeatedly advised on their heating habits. Omitting to adjust the water levels in the house system, disabling mechanical ventilation systems by leaving windows open, and the unavoidable (system-controlled) slow increase in room temperatures frequently caused reports of defects that turned out to be false alarms but disrupted system operations. Three years after the first tenants moved in, consumption figures show that residents have got used to their heating systems.

Literature

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USE OF RENEWABLE ENERGIES AND INNOVATIVE TECHNOLOGIES

Concept and Responsibilities

In the Energy Efficiency Optimisation programme within the Ecological Optimisation at Kronsberg EXPO project, the City of Hannover local authority set a target of reducing CO₂ emissions by 60%. To exceed this standard the City encouraged particularly innovative property developers to develop pilot projects. The City itself pulled down funding in 1996 from the European Commission (DG TREN) within the THERMIE Programme.

Using THERMIE funding, the City Environmental Protection Division set up a special programme for buildings with innovative and future-oriented energy technologies exceeding the Kronsberg Standard. To select suitable projects, a competition open to all developers on Kronsberg with two deadlines was announced. Content of innovative concepts for the competition was, in the first round:

- ecological building materials
- measures for electricity saving
- innovative building mechanical services
- integration of renewable energy technologies

and the second round comprised:

- measures for electricity saving and
- measurement programmes in the exemplary buildings.

The decision on awarding funding was made in two jury meetings, in August 1997 and June 1998. Chaired by the City Director of Environmental Services, the jury comprised local experts, mainly from the universities and local government officers. Nine of the 16 submissions were unanimously approved for funding.

Aims

Using renewable energy sources and innovative technologies, more CO₂ emissions were to be saved through a palette of pilot projects on Kronsberg. Transferability of the project ideas to other European locations was an important criterion in selecting the competition winners.

Results and Incorporation in the Planning Process

Despite the already very high ecological standards on Kronsberg and the very tight deadline for drawing up project proposals (just 5 weeks from the announcement), 16 developers took part in the competition for funding of projects with innovative energy concepts.

Of the nine selected and supported projects that were funded, only the 'Lummerlund' passive house development and 'Solarcity' are described here in detail. Other funding was directed to photovoltaic plants, while the two new wind turbines of megawatt-class on Kronsberg were erected without local government subsidies:

Lummerlund Passive House Development

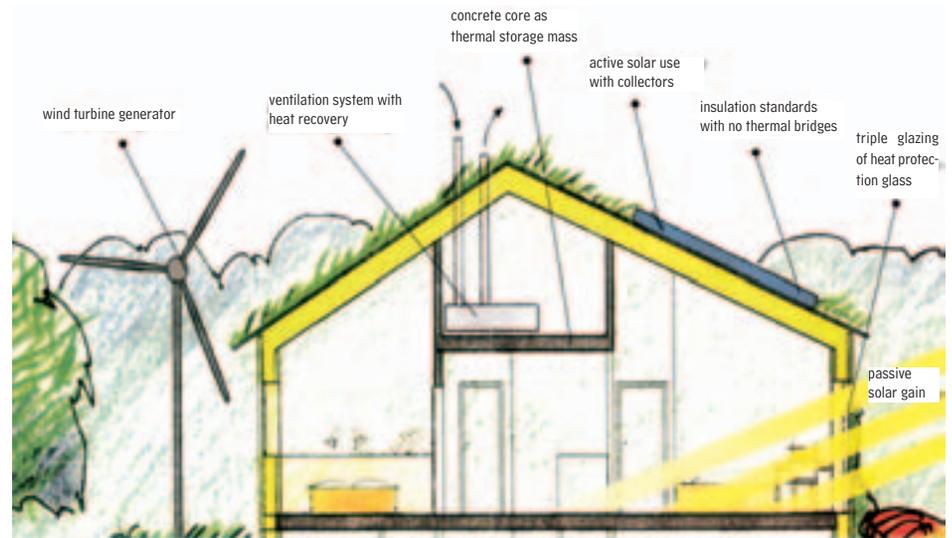
Lummerlund consists of 32 terraced family houses in 4 rows. The project aimed to set the following new standards for economical energy-saving construction:

- comfortable temperatures in summer and winter with minimal heating energy consumption using the passive house standard (15 kWh/[m²a]),
- very low energy consumption for hot water and electricity through efficient appliances
- covering remaining energy demand from renewable sources (thermal solar collectors for hot water, shares in the wind power plant).

The principle elements of the passive house energy concept are excellent insulation and the heat recovery system. Ceilings, roof and façade constructions are superinsulated, attaining k-values of 0.15 W/(m²K) and better with insulation thicknesses of up to 40 cm. All exterior building components are permanently airtight and have no thermal bridges. The k-value of the windows – high-quality heat protection triple glazing with insulated frames – is 0.8



'Lummerland' passive house development



Principle of a 'Lummerland' passive house

$W/(m^2K)$. South-facing windows act as solar collectors, and passive use of solar energy is thus the most important compensator for heat loss.

The passive houses also have exceptionally efficient ventilation systems with heat recovery plants. Used air is extracted from kitchen, bathroom and WC and passed through a heat exchanger before being released to the outside. When needed, this heat warms the constant supply of incoming air to the living rooms. A built-in filter prevents dirt accumulating in the incoming air ducts and heat exchanger. The development is also connected to the district heating system.

'Lummerlund' is a decentral EXPO 2000, and was funded by the City of Hannover, the CEPHEUS project (EU-THERMIE programme BU 0127/97) and 'proKlima'. Energy consumption of the passive houses was recorded in a special three-year programme (1999–2001). In 2000 consumption figures were very close to the target and in some houses considerably lower.

SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

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Thermal storage tank under construction



Climbing wall



Playground

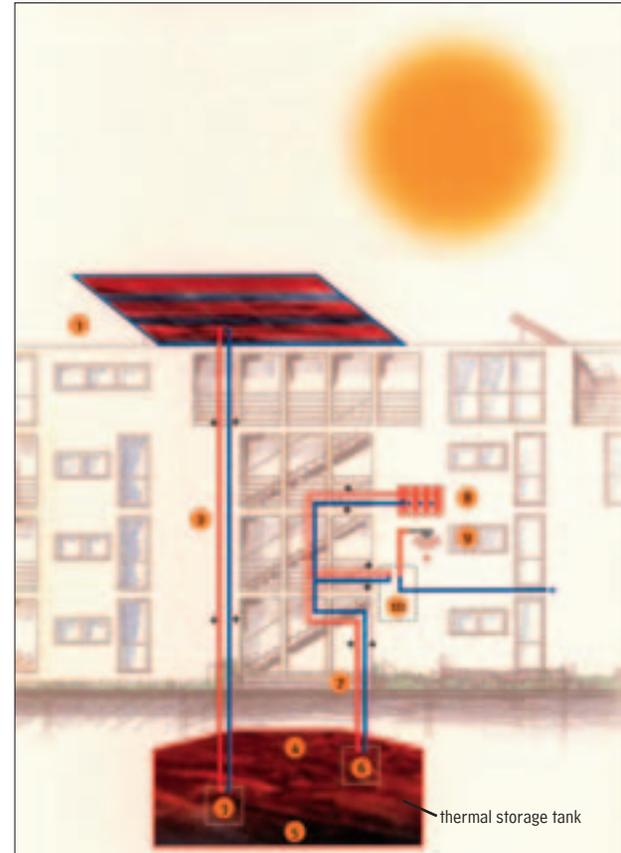


Solarcity

Solarcity

Solarcity is a pilot project to demonstrate the suitability of a large social housing complex for extensive solar energy provision. It is a joint venture by the GBH municipal housing association, the Avac energy company and the Niedersächsische Energie-Agentur. Along with funding from the City of Hannover's EU-Thermie programme it was also possible to acquire funding from the federal Ministry of Economic Affairs and Technology, Kronsberg Environmental Liaison Agency, Greater Hannover Local Government Association and Beton Marketing.

104 apartments in the Solarcity complex are heated from about 1,350 m² of thermal solar collector panels, which also replace conventional insulation on the south-facing roofs of the housing blocks. Superfluous solar energy in summer is piped to an extremely well insulated 2,750-m³ cistern, and thus solar heating is possible from spring through to December. This covers around 40% of the total heating demand, the rest being supplied by the



How it works ...

- 1 solar collectors
- 2 heat circulation
- 3 heat exchanger
- 4 water temperature 90° C
- 5 water temperature 40° C
- 6 heat exchanger
- 7 hot water circuit for apartments
- 8 radiator
- 9 hot water supply
- 10 heat exchanger

district heating network from the nearby heating centre. This use of solar energy dramatically reduces dependence on conventional fuels such as gas and oil.

The long-term thermal storage tank is built of dispersal-proof high performance concrete. The enhanced heat conduction resistance is due to special plastic additives and thus has both a structural and an insulating function, making it possible to dispense with internal stainless steel cladding. Heat loss is significantly minimised by the optimised volume/surface area ration of the cylindrical form and use of moistureproof foam glass granule insulation. The tank is set six metres into the earth. Its top area of around 530 m² protrudes about 4.50 metres from the site as a low hill: facing the district is a protective concrete wall, fitted as a climbing wall for the playground of the neighbouring kindergarten, and on the other side the tank is covered with earth and integrated in the landscaped site.

Costs of the solar collectors and underground thermal storage tank amounted to 3.3 million €; about 52% of this (1.7m) was for the collectors and 48% (1.6m) for the tank. About 65% of the total costs was covered by subsidies.

Photovoltaic Installations

Solar energy is used in the Kronsberg district for very limited electricity production. Photovoltaic installations can be found:

- at the district arts and community centre (KroKuS) – on the roof the south-facing grassed roof of the studio, an 8-kW_p installation produces about enough electricity for the centre offices. Current production is displayed to visitors on a panel in the entrance hall.
- at the primary school – a 2-kW_p photovoltaic installation, clearly visible on the carport roof, makes a symbolic contribution to the school's electricity needs. For educational purposes a display in the hall shows how much the installation produces each day and total production so far.
- and at the Stadtwerke CHP station – on the roof is a photovoltaic installation rated at 5 kW_p, of which 0.7 kW_p is used to turn it to follow the sun's course.

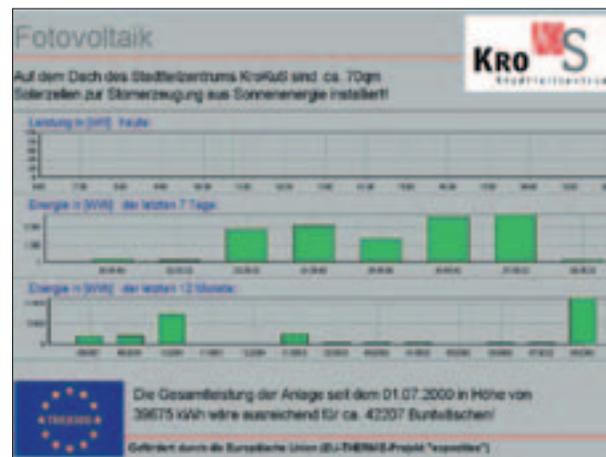
Together they deliver 17 kW_p. In 2000, total electricity production from the installations, some of which only began producing during the year, was almost 8,800 kWh, in 2001 11,900 kWh. The



Photovoltaic installation at 'KroKuS' arts and community centre



Stadtwerke Hannover AG photovoltaic installation



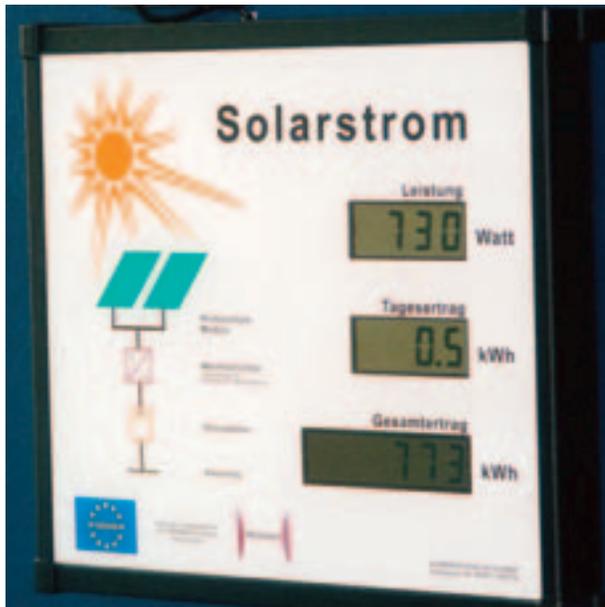
Performance of the photovoltaic installation at 'KroKuS'

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*Photovoltaic installation at
Kronsberg primary school*



*Display meter for the
photovoltaic installation*

installations on the district centre and the primary school were subsidised by the City of Hannover from THERMIE funds.

Wind Energy

The most important renewable energy source on Kronsberg is wind power. Stadtwerke Hannover AG has operated a small wind turbine (300 kW) on Kronsberg hill since 1990. As part of the development it is intended to erect three new wind power plants. There followed a tendering procedure for two plants run by the City Environmental Protection Division. The first turbine was commissioned in late March 2000 and the second began producing in June 2000.

The first turbine is a 1.8-MW converter, erected through contracting by the manufacturer on the land of the Herrmannsdorfer Landwerkstätten (Kronsberg organic model farm). Under the machine house, 60 metres up, is a viewing platform open to the public by appointment.



Wind turbine generators in the Kronsberg countryside

The second plant is rated at 1.5 MW. It was developed and erected within the project for EXPO 2000, one of four wind power plants erected in the Hannover region by the 'windwärts' operating company. A limited partnership was founded to finance and run the plants; the operating company's own capital amounts to 3.4m € provided by 378 private investor partners and a further 3.2m € was acquired through low-interest loans.

2001 was the first full operating year for the wind turbines, and data of electricity produced will be entered in the handbook as soon as figures are available.

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Concluding Observations on the Instruments

The energy consumption of new buildings is, along with municipal buildings, one area over which a local authority has direct influence on the implementation of energy-saving measures. As the Kronsberg example has clearly shown, the possibilities go far beyond setting conditions for the site construction; accompanying measures such as quality assurance monitoring through the planning and construction phases or public relations work are just as much a part of a good energy concept for new settlements as the exploitation of various regulatory instruments (prescriptions in the development plan, bylaws on district heating and legal

agreements such as land sale contracts) or supplementary funding programmes.

The following table summarises all energy-related instruments applied during the planning, development and construction of the Kronsberg settlement. The last column remarks on experience and lessons from praxis. It becomes clear that most instruments have had a very positive influence.

instruments	area	measures	experience in praxis
EIA	energy in general		positive, introduction to the issues
competitions	energy in general	urban and landscape planning design competition for EXPO & Kronsberg; urban design competitions for Bemerode-Ost	reserved, as receiving little consideration apart from the jury and the first prize winner
	district heating	EU-wide tendering for district heating on Kronsberg	positive, acceptable prices through competition, and innovative proposals (Solarcity)
development planning – the zoning plan	renewable energy sources	locations for wind turbines	positive
development planning – ‘B-Plan’ construction plan	LEH (compact structures) and district heating	building lines and boundaries	positive
	LEH and district heating	high floor space index (1.2 –0.5) and built area index (0.6-0.3) no detached or semi-detached houses, house groups of up to 4 storeys or terraced houses	positive positive
	LEH	insistence on closed building forms e.g. building on the edges of the block	positive
	district heating from decentral CHPs	decentral CHP location in cellars	positive, not all locations needed, important to have the options
	district heating	right to lay piping economically through front gardens and under buildings	positive, incentive payments for optimised routing
land sale contracts (also possible within urban construction contracts) See above	LEH	fixing a max. heating energy index of 55 kWh/m ² per year according to the Kronsberg calculation method for all buildings	positive, but better not to devise one's own calculation method, rather choose from what's available and alleviate hardship for small buildings
		setting five stages of quality assurance monitoring for LEH (including blower door test)	very positive in combination with subsidies instrument
funding	LEH (quality assurance monitoring incl. blower door test)	max. 50% of the costs of quality assurance monitoring (for the local authority up to 5 €/m ² of heated space)	very positive together with the land sale contract instrument
	electricity saving	25 € per extra hot water connection fixed in the quality assurance funding guidelines	positive, good response
		50 € grant towards the purchase of each energy-efficient household appliance	Programme on Kronsberg started well but targets not reached – continuity needed
	LEH	skilling and qualification measures for planners, craftspeople and residents	positive
		integrated planning	positive
		social housing construction subsidies linked to climate protection clauses	positive
renewable energy sources	subsidies for photovoltaic installations and ‘Solarcity’	positive	
district heating bylaw	economically viable district heating (decentral CHPs)	compulsory connection and use – duty of provision	mixed; for: very high rates of CO ₂ reductions, ‘same prices’; against: created a heavy workload for the City administration; exemptions for users of solar energy needed; setting standard prices among various suppliers troublesome

3.3 WATER CONCEPT

One task of sustainable urban development is always to hinder the negative and thoughtless use of water. On Kronsberg an appropriate concept was devised with three components:

- a semi-natural decentral rainwater management system
- drinking water economies
- awareness raising among residents for water issues.

Rainwater Management

Concept

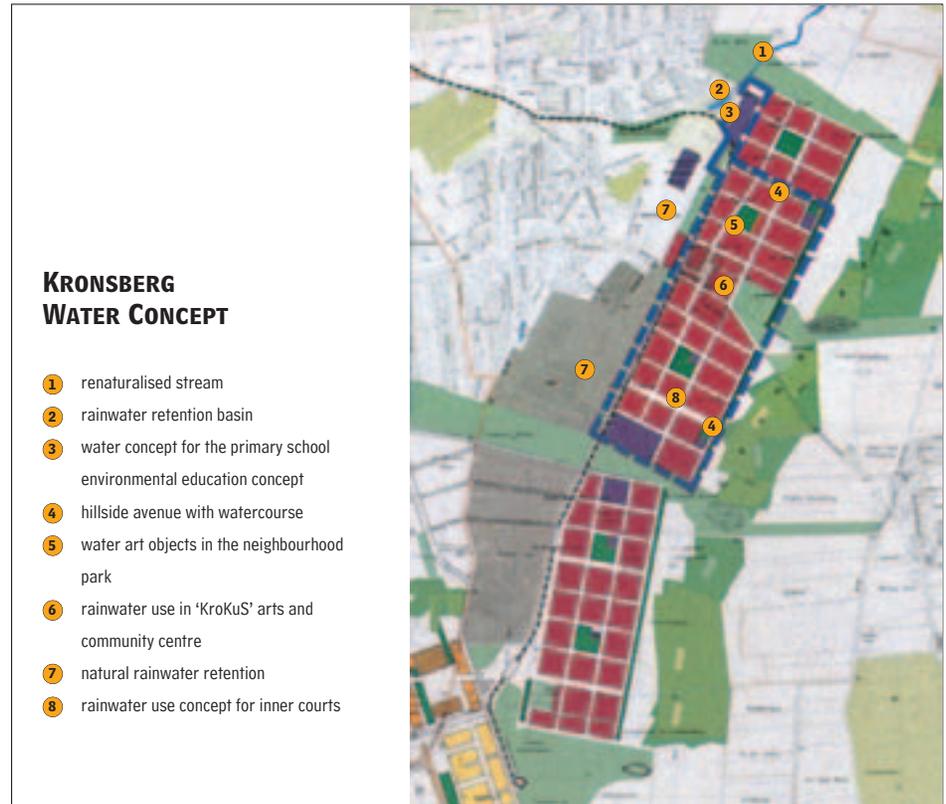
Large scale development causing large areas of land to be rendered impervious usually leads to dramatic changes in the balance of natural water resources. On the one hand paving and building reduces the amount of water that can infiltrate and the water table falls. On the other hand direct rainwater run-off means that water levels rise suddenly and flooding occurs in the drainage watercourses.

Recent flood disasters have made the hazards of widespread building measures emphatically plain! On Kronsberg, too, hydrological surveys in tandem with the environmental impact analysis revealed that conventional storm water drainage from the new district would lead in the long term to a serious fall in the ground water table in nearby woodland, and that there would be extreme variations in the volumes carried by the 'Rohgraben' stream, the only watercourse draining this area.

In order to make construction development environmentally sound despite this difficult situation, a semi-natural drainage concept was developed to minimise the effects of development on the natural water balance.

In order that run-off from the area would not increase, for the entire development area a limit of 3 litres per second and hectare was set for the volume of water released into the drainage stream.

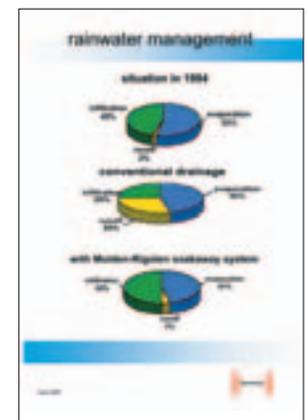
The poor permeability ($k_f = 10^{-6} - 10^{-7} \text{ m/s}$) of the local soil meant that channelled infiltration alone of storm water was impracticable, and a concept was developed combining infiltration, decentral and semi-decentral retention, and controlled and



delayed release into the stream, resulting in a semi-natural rainwater management system with both surface and underground components. A central feature of this concept is the 'Mulden-Rigolen-System' of grassed hollows and pebble-filled infiltration trenches covering the entire district along both sides of the roads.

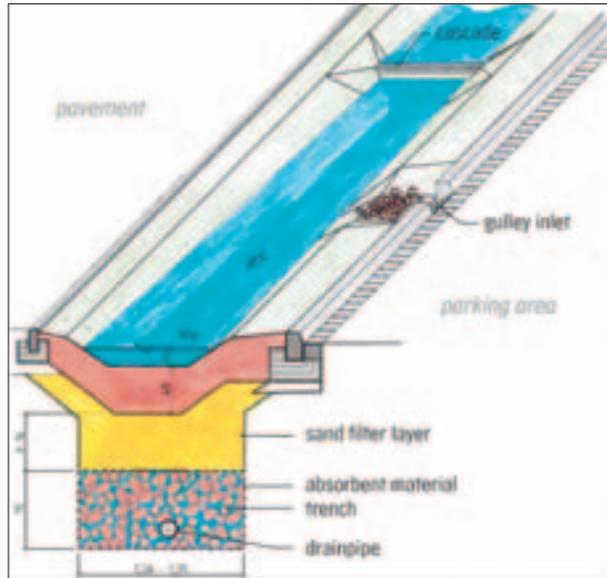
Aims

The aim of this semi-natural rainwater management system is to preserve as far as possible the original natural drainage situation on Kronsberg hill so that run-off from the area after development is the same as before.

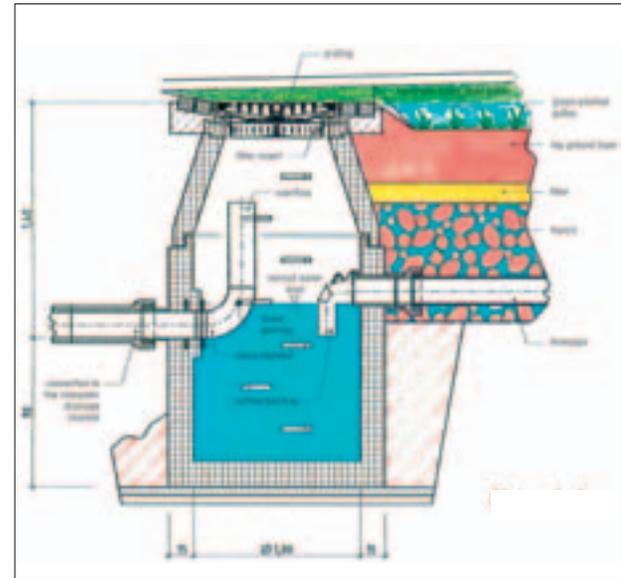


SUSTAINABLE URBAN DEVELOPMENT SOLUTIONS AT THE URBAN PLANNING LEVEL

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'Mulden-Rigolen-System' – section through the drainage trench



Limited flow shaft



Roadside drainage

Achieving this aim for such a large homogeneously planned construction area can be regarded as a model of international significance, particularly as the soil has poor infiltration qualities.

The objectives of minimising sealing of surfaces and optimising rainwater infiltration and retention are intended to achieve immediate and mostly direct replenishment of the groundwater and surface water. Water that is not infiltrated is channelled via the Rohrgraben stream to the regional water resources.

Implementation

Decentral retention was foreseen as the basic principle for the entire development area – as much rainwater as possible retained and infiltrated on site in public and private spaces.

Various constructions were used:

- 'Mulden-Rigolen-System' hollow and trench
- regulated run-off drains
- retention areas
- retention basins
- drainage stream

When the infiltration areas – especially along the roadsides – cannot cope the 'Mulden-Rigolen-System' takes over: rainwater runoff is channelled from the roads into long grassed hollows and retained there. Through a topsoil layer that cleans it, the water soaks into a trench filled with small stones (the 'Rigole') from which it infiltrates on three sides into the soil. In cases of extreme rainfall, surplus water is channelled to large retention areas and green corridors on the edges of the development. The many small areas of open water facilitate evaporation, improve the microclimate and reduce dust. Park-like retention areas and the retention basins provide flood protection by releasing heavy rain gradually into the drainage stream.

To collect data to optimise the construction phase a 1:1 scale demonstration stretch of 'Mulden-Rigolen-System' was built before the entire project. Along with findings to feed into the construction phase, this tested reliability of drainage from small regulated openings, the best gradients for the hollow sides derived from the sloping construction area, and performance under extreme rainfall conditions. All this made it possible to incorporate improvements at an early stage.



Landscaping in a private inner court



Hollow and trench drainage system



Rainwater retention pond at the primary school

The main task in applying the concept was to ensure that plans and working drawings were in accordance with the overall water concept. For this, to assist all stakeholders in the tendering procedure, awarding of contracts and construction supervision, a handbook was compiled for the civil engineering companies explaining the essential construction principles of the 'Mulden-Rigolen-System'. Detailed descriptions of the relationships between components and methodology made the single phases of construction and quality monitoring easier.

The 'Mulden-Rigolen-System' and retention areas for public spaces were planned by and constructed under the supervision of the City of Hannover Water Treatment Services. Deep workings and road construction and construction of the 'Mulden-Rigolen-System' were so closely related that the City Highways Division and Water Treatment Services issued a call for tenders jointly.

The private building plots were divided into single blocks and sold to different property developers. Before starting construction, they had to demonstrate to the City Water Treatment Services with detailed construction plans that they could meet the objectives for rainwater management stated above. For the granting of construction permits, comprehensive advice to planning bureaux on the framework conditions was necessary. Detailed coordination between the various divisions of the local authority, planning bureaux and construction companies was another important prerequisite for the success of the project.

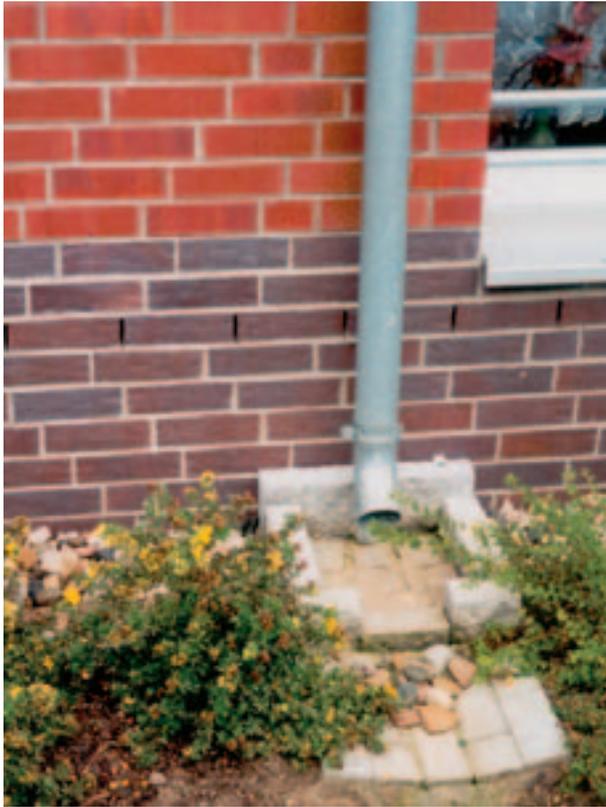
Planning Instruments

The basis for the water concept was hydrological surveying completed in the preliminary planning phase, which showed that sealing the soil with conventional development on Kronsberg would have a massive influence on groundwater conditions. Results of investigations carried out in 1990–1995 as part of the process Environmental Impact Analysis created an early demand for a rainwater infiltration concept. To ameliorate possible negative consequences of development, criteria for this were set in the 1993 land use plan.

The development plans insisted on use of the 'Mulden-Rigolen-System' for public streets. The drainage volume limit of 3 l/(s x ha) was included in the written statement accompanying the plans and included in the water engineering clauses of planning permissions. As impact minimisation measures according to nature conservation law, owners of building plots were obliged to pave parking spaces and access roads with surfaces that allowed water to infiltrate, to plant vegetation above underground garages that were not beneath buildings, and to plant gently-sloping roofs in some defined parts of the construction area.

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Drainpipes and gullies

The variety of ecological requirements on Kronsberg is also apparent in the selection of construction materials. Both the city's Water Treatment Services in public spaces and the private sector developers had to use environmentally compatible building materials and, for example, do without PVC for drainage pipes. This condition was applied to private sector developers through the land sale contracts.

Organisation and Active Participants in the Project

Devising an agreed rainwater concept was contracted out by Hannover water treatment Services to the 'Planungsteam Wasser', comprising the civil engineering bureaux 'Atelier H. Dreiseitl' from Überlingen, 'ifs, Ingenieurgesellschaft für Stadthydrologie mbH' from Hannover and 'itwh, Institut für tech.-wiss. Hydrologie, Prof. Sieker' also from Hannover. The team was led by itwh.



The 'Mulden-Rigolen-System' was also the object of the University of Hannover Institute of Water Management's 'Regenwasserbewirtschaftung Hannover-Kronsberg' research project funded by the federal Ministry of Transport, Construction and Housing.

The central instrument for organising and coordinating the activities of all stakeholders – investors, construction companies, planners, users and operators of the systems – was the construction handbook containing a description of the construction sequence and quality assurance concept giving advice to construction companies and deadlines for completion of phases, and sequence of sections to be commissioned and handed over to the operator.



Water sculpture on the district square

Finances

According to a cost comparison carried out after the development was completed, decentral rainwater management for public spaces is more economical for the City Water Treatment Services than conventional drainage systems. Minimising the areas sealed by paving and buildings reduces the need for rainwater retention facilities. Removing the need for street drains and environmental compensation measures according to nature conservation law also saves money. Looking only at the capital investment cost, decentral rainwater management is around 8% more economical than conventional drainage systems; the decentral system cost 22,686,000 DM (11,599,167 €) while conventional drain construction would have cost 24,656,000 DM (12,606,412 €). The specific investment costs worked out at around 67 DM/m² (34 €/m²) of built-up area.

From a politico-economic perspective, along with the primary financial aspects the secondary ecological and social effects must also be considered, as evaluation of water management measures must be based on whether they improve the quality of life. With the help of a cost-benefit analysis (12) it could be shown that particularly because the rainwater management measures could be taken into account as environmental compensation measures according to nature conservation law, there was a cost advantage for the decentral semi-natural system.

For private sector property developers viability studies (12) showed that 'the investment costs of decentral rainwater management are to be assessed as on average about 25% higher than conventional drainage'. However, according to § 4 (2) of the current table of charges (13) c. 70% reductions in rainwater disposal charges more than compensates for this difference.

Drinking Water Economies

One aim for the Kronsberg development was to reduce drinking water consumption as much as possible. This was achieved through fitting water-saving devices in apartments such as water-air mixers, flow limiters and constant flow regulators, installation of water meters in all apartments and environmental education measures.

The idea of laying a network of rainwater supplies for uses that did not require drinking water quality (toilets, watering green-space, and possibly washing machine connections) was not successful. A system at the nearby World Exposition grounds proved to be uneconomical and a faulty connection caused serious hygiene problems.

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Semi-natural water concept

Awareness-raising among Residents for Water Issues

To emphasise the importance of water as a basic element and to sensitise public opinion for the issue, water was used in many ways as a feature of urban design on Kronsberg. In the courts of the housing complexes infiltration and retention areas were integrated in the semi-natural design of the open spaces, on the two hillside avenues broad green spaces were laid out with open water features, streams and ponds, and in the neighbourhood parks fountains and water features create a special open space quality.

Presentation of the project, public relations and publicity work, and putting across the issue of water and its importance was taken on by KUKA, which carried out special education and advice measures in collaboration with the City Water Treatment Service.

The new Kronsberg primary school is an important part of this communications concept: open rainwater drainage, retention and infiltration areas are integrated in the school grounds. Some of the rainwater is collected in a cistern and used for toilet flushing and watering the school garden. In the environmental education curriculum water is a central topic, and in these ways the school is an important 'behaviour multiplier' for pupils and parents.

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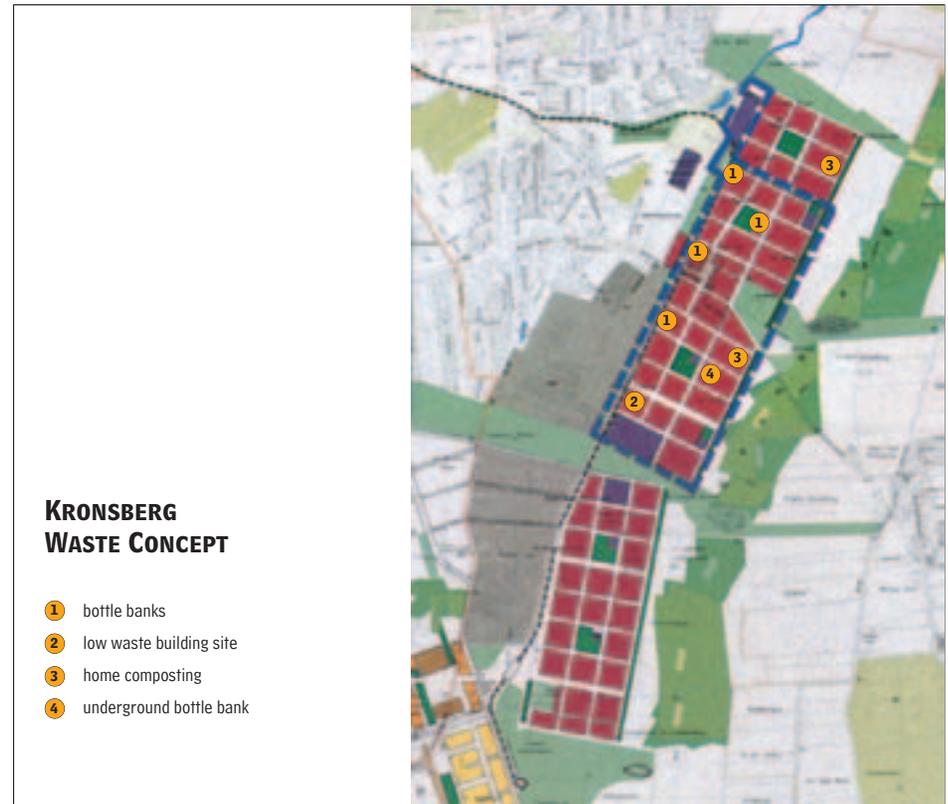
3.4 WASTE MANAGEMENT CONCEPT

By controlling the materials flow, the Kronsberg waste concept dramatically reduced the quantities of both construction waste going to landfill and of domestic and commercial waste. The primary objective was waste avoidance and recycling on site wherever possible.

Concept

The Kronsberg waste concept was twofold: the construction waste concept and the domestic and commercial waste concept.

Construction waste makes up a considerable proportion of Hannover's total waste production – around 40% by weight. During the construction phase it was the developers' responsibility to give top priority to low-waste building methods. Within the construction waste concept, they signed contractual agreements with the City of Hannover to use only environmentally compatible building materials at Kronsberg. This covered avoidance of most materials with harmful constituents that could cause problems and higher costs when disposed of later as hazardous waste. Additionally, the 'Low Waste Building Sites' model project was set up. This innovative scheme aimed at making significant reductions in waste compared to other building sites and thus applying the ideas of the cyclic economy (see also under Aims).



Sorting construction waste



Waste sorting guidance sign



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Bottle banks

The essential component of the domestic and commercial waste concept was setting up innovative collection systems. Close to the apartments, well-designed container points make it easy to dispose of waste sorted into organic, paper and cardboard, glass and packaging. In the home, some rubbish is sorted into built-in bins. Outside the buildings, residents use collection points with rubbish and recyclables containers. On a larger scale, this system is backed up with a recycling depot, built after the district was finished on a reserved site by the main access road. An important feature of the domestic and commercial waste concept is home composting of organic waste. There is a range of low-waste goods available in the Kronsberg shops and extensive services to combat the 'throwaway mentality'. Other projects such as a Local Exchange Trading System, an appliance and tool lending scheme, joint car use organisation and a launderette all help to save resources. A KUKA advice service on the possibilities of low-waste consumer habits, waste sorting and composting was offered to both residents and businesses.

Aims

The overriding aim of the Kronsberg Waste Concept was preventative waste management planning, as opposed to conventional waste disposal schemes. During the planning and construction phases, the objective of consistent waste avoidance and recycling were foregrounded. Hazardous substances in the waste were to be excluded as far as possible or reduced by appropriate pre-treatment. Recyclable wastes were to be fed back into the mater-

ials cycle in an environmentally responsible way. As far as required for the environmentally compatible recycling of waste, these were to be appropriately treated. Unrecyclables were to be sent to landfill after appropriate pre-treatment to render them ecologically safe.

The City Waste Management Services, 'Abfallwirtschaftsbetrieb Hannover' (now Abfallwirtschaft Region Hannover – 'aha') devised the 'Low Waste Building Sites' model project for the construction phase to sort waste on site, achieving 80% recycling rates. Intensive waste avoidance measures also led to substantial reductions in waste quantities. These included avoidance of packaging during the construction process and preference for materials delivered with little packaging, selection of durable materials resistant to damage and without hazardous constituents, observance of recyclability, use of recycled materials, constructive sorting of materials with different usable lives and the application of low-waste building methods.

In cooperation with the Institut für Bauforschung e.V. (IfB), the Environmental Planning Group for the World Exposition (K/2000) produced in advance a comprehensive catalogue of environmentally compatible building materials. The framework objectives were avoidance of chemical wood preservatives and tropical wood, prohibition of materials containing asbestos, PCBs, PCPs or lindane, rejection of materials containing aluminium, CFCs, formaldehyde, PVC or isocyanates, use of mineral fibre only when no fibres could penetrate indoor spaces, and use of paints, varnishes and adhesives with little or no solvents.

The aim of the 'Exemplary Domestic and Commercial Waste Concept' was to reduce waste quantities by 50%. Important components were collection points close to or integrated in the buildings for sorted collection, encouragement of home composting and a range of services that, under the motto 'reparieren statt deponieren' (Mend it, don't dump it), set up a close network of repair and alteration services.



Implementation

An information event in early 1996 on ‘Environmentally Compatible Building Materials and the Exemplary Waste Concept’ and on ‘The Kronsberg Exemplary Domestic and Commercial Waste Concept’, at which numerous experts spoke, was intended to encourage widespread acceptance of the waste concept. Developers, architects and construction consortia involved in the planning and construction at Kronsberg were invited and comprehensively informed about concrete implementation possibilities.

Inclusion of the waste management objectives had an effect above all on the land use relationships. Along with locations for waste collection points, provision had to be made for the following structural facilities:

- recyclables and waste sorting in the apartments,
- areas for individual and communal composting (including management and logistics), and
- local facilities for low-waste shopping.

The City of Hannover Environmental Planning Group for the World Exposition, in collaboration with KUKA, supported developers during the construction phase with recommendations and specific advice.

Planning Instruments

In the written statement to the development plan it was determined that an environment and recycling depot should be built in the commercial area to the west of development area No. 1552, but as the Kronsberg collection area is markedly smaller than originally imagined, the depot would not be commercially viable and this has not happened. It was also laid down that a recyclables collection point should be established for every 400 residents.

Within the land sale contracts or urban development contracts, regulations covering the entire district were laid down on environmentally compatible building materials, on construction waste and on domestic waste. With the contract, purchasers committed themselves to using only building materials whose production, installation, function and disposal were health- and environmentally compatible, and with low embodied energy for produc-



Enclosed waste collection points

tion and disposal. The materials should also have high recycling value, and their use should create little waste.

Determination of the use of environmentally compatible building materials was fixed in the land sale contracts or urban development contracts and followed the recommendations of the Environmental Planning Group for the World Exposition, K/2000 (s. Appendix 6).

Furthermore, purchasers were contractually obliged to build locations for recyclables containers and maintain them, and to provide areas for home composting in terrace house developments.

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Underground bottle banks

Organisation and Active Participants in the Project

The concept for the 'Environmentally Compatible Building Materials' project was devised by the Environmental Planning Group for the World Exposition (K/2000) at the City of Hannover Environmental Protection Division, in collaboration with the Institut für Bauforschung e.V. (IfB). The 'Exemplary Construction Waste Concept' was devised by the City Waste Management Services in collaboration with the Wissenschaftsladen Hannover e.V. and IMS Ingenieurgesellschaft mbH.

Overall coordination of the waste concept as a sub-project within Ecological Optimisation at Kronsberg lay with the Environmental Planning Group for the World Exposition at the City Environmental Protection Division.

Presentation of the project, public relations work and work for acceptance of the measures was taken on by the Kronsberg Environmental Liaison Agency (KUKA), who staged special advice and information events in collaboration with Waste Management Services.

Finances

Pre-sorting of construction waste was also economically viable in the context of the City of Hannover's differentiated waste charges. At a recycling quota of 80%, disposal costs for construction waste (skips, transport, disposal) were less than half. Participation in the model project was subsidised by Waste Management Services with up to 12,782 Euro per applicant.

After occupation, also, waste quantities in households could be reduced using the pre-sorting system. Home composting, for instance, also significantly reduced waste collection charges.

Communal composting at Kronsberg was subsidised through a grants programme. While in single houses with gardens the necessary infrastructure is available and the logistics clearly the responsibility of one party, communal composting is more costly to organise. For this reason, Waste Management Services subsidised construction and housing associations and house-owners for composters and laying out the sites up to a maximum of 1,500 DM (767 €).

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3.5 SOIL MANAGEMENT

Since 1996, national legislation on the cyclic economy and waste demands recycling of soil, with a priority on waste avoidance. However, through to the commencement of construction on Kronsberg there was a lack of experience and benchmarks for the necessary organisational form of ecological soil management for projects of this magnitude. The concrete implementation of ecological soil management on Kronsberg, which was pursued in exemplary fashion throughout the construction phase, thus sets a model for other projects nationwide.

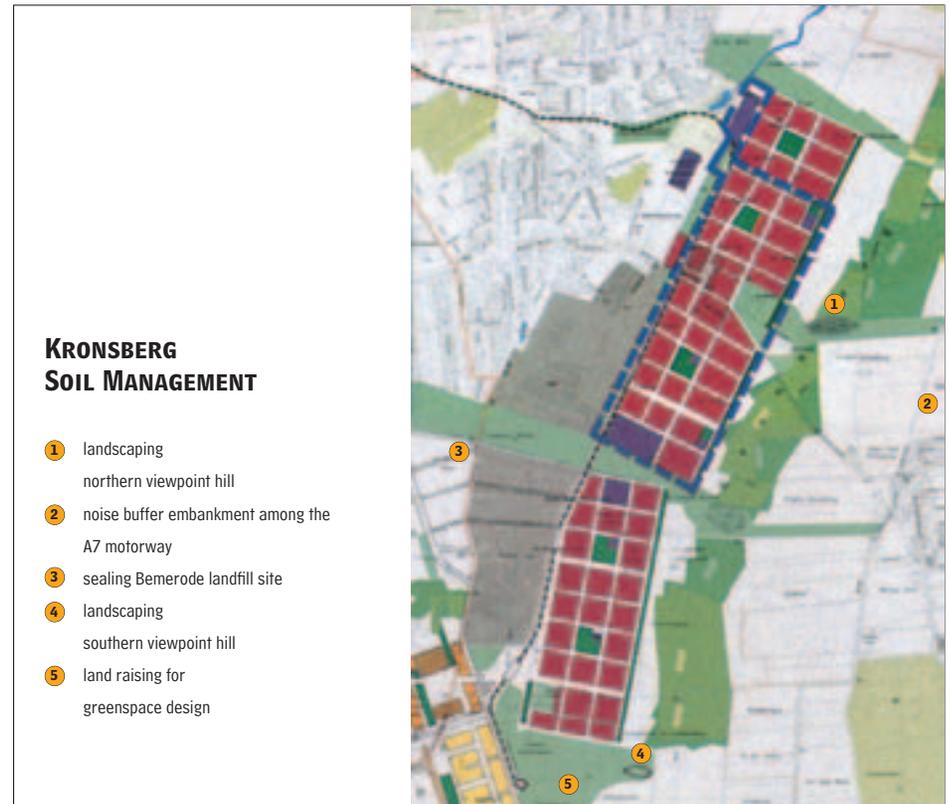
Concept

The central concern of soil management on Kronsberg was direct recycling of the entire excavated volume in the vicinity for landscaping and environmental enhancement. Ecological soil management rejected the idea of treating soil as waste, regarding it as valuable raw material to be exploited to the full, both ecologically and economically. The task was to redistribute this resource close to the site for high ecological gain.

Through to 2000, construction of almost 3,000 homes and the concomitant infrastructure produced around 700,000 m³ of excavated soil. The approximately 100,000 truck journeys to landfill that this would normally entail would have meant serious nuisance from noise, dust and traffic for residents of the surrounding residential areas and a heavy pollution load in general. Through the ecological soil management system, this expensive and environmentally detrimental transportation to faraway landfill sites could be avoided.

Furthermore, there was a danger that inappropriate use of the limestone marl and chalk soil from Kronsberg in other areas could have led to problems with changes in soil and biotope conditions. Foundation surveys showed that the characteristics of the Kronsberg soils demanded a special procedure with regard to vehicle use, construction and recycling. This was another reason for recycling on or close to the construction site.

To minimise the traffic load and open up ecologically sensible recycling potential, excavated soil was immediately recycled for semi-natural landscaping and enhancement of open spaces and



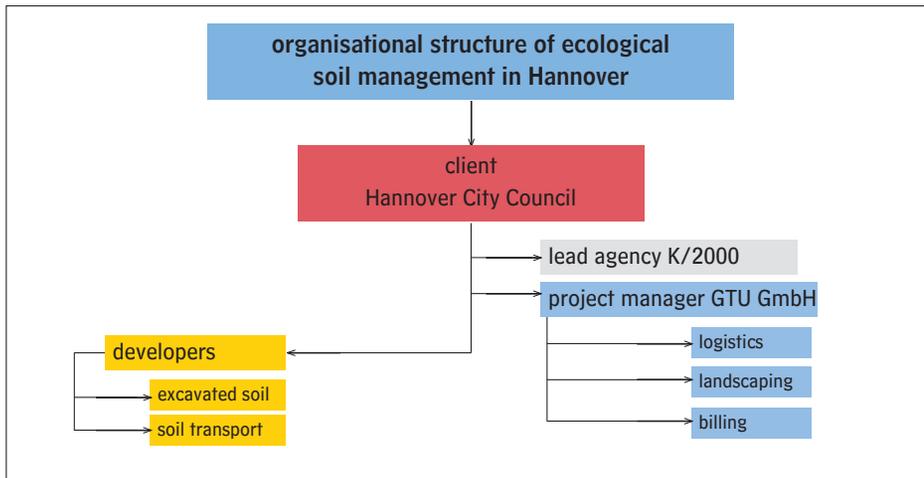
the adjacent countryside. Numerous landscaping construction measures and the creation of biotopes close to the residential area were made possible through the recycling of excavated soil. The prerequisite for using excavated soil on site was a differentiated management system that ensured minimal excavation right from the initial planning phase. Soil management began in 1996. Numerous landscaping measures and the creation of biotopes in the immediate vicinity of the residential area were made possible through recycling this excavated soil: the two viewpoint hills on the crest of Kronsberg offered themselves as the first recycling sites.

Aims

The essential aim of ecological soil management was to provide ecologically sensible recycling possibilities for excavated soil as

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close to the site as possible and to organise transport to the reuse site in an environmentally compatible and economically viable fashion. This created the following framework conditions:

- avoidance of truck journeys out of the Kronsberg area
- avoidance of truck journeys into Kronsberg (i.e. no deliveries of soil for landscaping)
- transport of excavated soil within the construction area that minimised mud, dust and compacting of the Kronsberg soil, which is in any case difficult to build on, being a mixture of clay, loam and limestone marl.
- development of typical local biotopes through directed recycling of excavated soil
- cost reduction for service and access charges for both developers and the municipality through reductions in transport and landfill costs.

Implementation

The foundation for ecological soil management was a preliminary planning phase with a feasibility study and orienting site investigations. A survey of the prevailing conditions before work starts and collation and guidance of the development potential of the new soil or locations are the professional preconditions for treatment of excavated soil appropriate for the location, substrate and use. In an ideal case, the new soil profile should resemble the

old one in its characteristics; the soil's functions should not be limited but rather improved.

Fundamentally, before planning begins the possibility of soil contamination and waste accumulations must be excluded. Preliminary investigations on Kronsberg, which had been almost exclusively used for agriculture until then, showed no traces of contamination in the proposed construction area.

The next step towards ecological soil management was preparation of a recovery and reuse concept which would facilitate total recycling of excavated soil, including topsoil, within the Kronsberg countryside (project development and acquisition of recycling possibilities). The reuse locations were to lie within or a short distance from Kronsberg area. The main landscaping measures for the reintegration of the soil in the immediate vicinity of the construction area were:

1. raising soil levels in part of the construction area
2. a noise buffer embankment along the nearby motorway
3. viewpoint hills on the crest of Kronsberg hill
4. sealing an old landfill site in Bemerode.

The spatial management of soil resources was supported by a specially developed data processing system. For subsequent project control, all data on soil conditions, areas, construction measures and reuse possibilities were collated in a databank. By linking this databank to a profiled geographical information system, reuse and redistribution of soil materials could be planned and guided. This data could be applied to every single excavation. Links made it possible to collect precise information on excavated quantities for both single construction blocks and for larger areas. After the reuse areas had been acquired the quantities of excavated soil could be purposefully redistributed.

Planning Instruments

Right from the process-based Environmental Impact Analysis, a preliminary study examined the expected quantities and reuse possibilities of excavated soil on Kronsberg. These early studies of the amount of soil and resultant environmental and transport problems meant that an innovative soil conservation and reuse concept could be established right from the preliminary planning



Northern viewpoint hill



Southern viewpoint hill



and woodland planting on the crest of the hill

phase. Concurrently the objective was set of providing developers and all those involved in soil movement with full details of the foundation soil investigations across the entire area, and organising an economical reuse system for uncontaminated excavated soil.

The requirements of ecological soil management were taken into account in devising the construction plans (low land take through compact built forms, efficient access, multi-use of areas, integration of infrastructure facilities in the residential buildings, efficient building plot outlines).

Implementation of the soil management scheme was defined by clauses in the land sale contracts or the urban development contracts or (with other partners and users such as the EXPO Grund GmbH property company) in separate contracts. These contracts stated that all superfluous excavated soil and topsoil which could not be reused on the building site must be delivered free, and that the municipality or a delegated body had the power to determine the location for reuse. Additionally, the contracts set the billing methods per m³ of reusable soil for use of ecological soil management system. Through the land sale contract or the urban development contract, the purchasers committed themselves to participating in the 'Ecological Soil Management on Kronsberg' scheme.

Organisation and Active Participants in the Project

The Ecological Soil Management on Kronsberg scheme was devised by the Ecological Planning Group for the World Exposition based at the City of Hannover Environmental Protection Division,

in partnership with a civil engineering office and in consultation with the affected municipal services. The project client for the scheme was thus the City of Hannover. Lead agency was K/2000, reporting to the Environment Directorate, which coordinated the project through all its phases, and commissioned a civil engineering consultancy to take responsibility for logistics, construction site monitoring and documentation of soil recycling.

In collaboration with the City's Greenspace Division, the project managers also took charge of soil deposition and billing with the developers and the municipality. Transport of excavated soil to the recycling location was however, the responsibility of the developers. Compelled through land sale contracts, urban development contracts or service contracts to participate in the soil management programme, developers could inform the project manager shortly before excavations began of the expected quantities, and be informed of a reuse location as close as possible, and the route to it.

Finances

For the City of Hannover, Ecological Soil Management produced financial advantages: not only was free soil suitable for landscaping measures made available but deposition and construction site costs for landscaping could be saved, and superfluous soil from the City's own site service and access building works could be more economically reused.

For developers, the short distances to new locations for excavated soil considerably reduced their disposal and transport costs that would usually be incurred through journeys to landfill.

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Earthmoving

Deliveries of soil by the construction companies to the new location were checked and documented for billing. All developers were billed for use of the Ecological Soil Management on Kronsberg service by through a standardised fixed-price tipping charge. The costs of the service arose through the project manager's fees for logistics and billing and the placement and landscaping on site. Costs of excavating the soil and transport to the reuse location were born by the developer.

The costing was based on quotations from civil engineering offices for project management and the market prices of projected soil deposition cost. The tipping fees comprised logistic and billing charges, cost of landscaping delivered soil and cost for site access and safety measures per m³ of recyclable soil. The business concept was devised on the assumption that all developers would be obliged to join the soil management programme, and tipping fees were set to cover costs, thus making it possible for the City of Hannover to finance the entire project on a cost-neutral basis.

The soil management programme recycled 78% of excavated soil within 4 km of its original location; only 12% was used further afield.

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KRONSBURG COUNTRYSIDE

- 1 woodland planting
- 2 common (sheep grazing)
- 3 orchard meadows
- 4 grassland
- 5 residential and commercial area
- 6 EXPO area
- 7 tram
- 8 wind turbine location
- 9 northern viewpoint
- 10 border avenue
- 11 sealing Bemerode landfill site
- 12 noise buffer along the A7 motorway
- 13 southern viewpoint
- 14 Bockmerholz green link
- 15 Kronsberg farm – 'Herrmannsdorfer Landwerkstätten'



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Registration certificate for 'City as Garden' as Expo project

3.6 CITY AS GARDEN

For the first time at a World Exposition, exhibits were created outside the exposition grounds – the 'Decentral Expo Projects'. As well as 'Ecological Optimisation at Kronsberg' the City of Hannover also entered its 'City as Garden' project in the EXPO competition, 'City and Region as Exhibit', and it was approved as a decentral project.

Concept

Within the 'City as Garden' project, throughout Hannover over 30 different projects were carried out around the themes of 'New Settlements', Historical Gardens and Parks' 'Landscape Spaces' and 'Environmental Education and the Gardens Culture'. These five themes were mainly presented in four large 'garden spaces', closely linked to each other. One of these garden spaces was Kronsberg, whose garden concept encompassed:

- the open space concept in the new district
- shaping and enhancement of the countryside
- 'Spiel- und Sportpark' and the 'Parc Agricole'
- 'Herrmannsdorfer Landwerkstätten' (Kronsberg farm)

Through these projects, all 'City as Garden' themes with the exception of 'Historical Gardens and Parks' could be implemented in exemplary fashion on Kronsberg. Together with Ecological Opti-



Border avenue



Common

misation, the garden projects constitute one of the bases for consistent sustainable development across the entire Kronsberg area.

Projects on Kronsberg

The open space concept for the Kronsberg settlement constitutes a unity with the urban construction concept – the entire district is criss-crossed by a green network of variously designed open spaces with varying degrees of public access: private or communal, semi-natural gardens and open spaces in the inner courts are linked by footpaths to the green corridor parks, which in turn link the settlement with the common land on the crest of Kronsberg hill and the nearby countryside. Centrally located within the grid



Sports and games park



Parc Agricole

layout of the streets are the neighbourhood parks, serving as public open space and meeting places.

The aim in enhancing the countryside was to create a striking landscape on the Kronsberg agricultural land and to emphasise its natural spatial qualities. The settlement's hillside avenue parks reach into the countryside and are linked via the afforested crest of the hill, foregrounded with the swathe of common land, separated from the settlement by the kilometre-long border avenue. The viewpoint hills, built of excavated soil from EXPO construction measures, offer a panorama of the entire city and the countryside. A many-branched footpath network has been created that reaches out into the Hannover region.

The 'Spiel- und Sportpark' and the 'Parc Agricole' are the two green corridor parks so far laid out, of which five will later cross the settlement. The 'Spiel- und Sportpark' will, long-term, provide sports grounds for the new settlement. It offers a green foot- and cycle route from the district of Mittelfeld to Kronsberg and will later extend as far as Wülferode. The 'Parc Agricole' in the southwest of Kronsberg reaches to the eastern part of the World Exposition grounds. It includes a walled garden with layered limestone, broad meadows for sheep grazing and an orchard meadow.

The 'Herrmannsdorfer Landwerkstätten am Kronsberg' farm and rural workshops are part of the Agri-Expo project, 'Environmentally-friendly Agriculture and Regional Marketing on Krons-



Kronsberg farm

berg'. Covering around 100 hectares, the farm is run on AGÖL (Association for Ecological Agriculture) guidelines as a response to the specialisation and spatial monotony of industrialised food production and the increasing disconnection of agriculture from regional economies. Produce is processed on site and sold at the farm or nearby. The farm also takes on landscape maintenance for public greenspace in the Kronsberg countryside. At the time of writing, however, the Herrmannsdorfer Landwerkstätten are beset with economic problems and a new concept for the retention of the entire Kronsberg Farm is being devised.

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To mediate between the interests of recreation, agriculture and nature conservation, 'Fieldworkers' were appointed whose main responsibilities were to be on hand to assist in all issues pertaining to the Kronsberg countryside and to provide information and advice. Talks were held and excursions around Kronsberg organised. The posts were funded by the federal nature conservation authority (Bundesamt für Naturschutz) as a model project.

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Planning instruments

The bases for the Kronsberg 'City as Garden' projects were the altered zoning plan and the landscape plan within the zoning plan as approved by the City Council. Both were determined by the process-based Environmental Impact Analysis and the results of the urban and landscape planning competition and the urban construction competition. Designs for the two neighbourhood parks so far constructed were derived from the results of a landscape planning competition.

In addition to the conditions of the construction plan, the land sale contracts and urban construction contracts guaranteed creation of designed private space in the spirit of the open space concept through civil law agreements.

Finances

Principle co-funders with the City of Hannover were the Greater Hannover local government association (Kommunalverband Großraum Hannover), federal government and the EXPO 2000 corporation (EXPO Hannover GmbH). Additionally, the federal nature conservation authority (Bundesamt für Naturschutz) funded important parts of the landscape concept for Kronsberg within the model pilot project 'Nature Conservation, Recreation and Agriculture on the City Margins' (Naturschutz, Naherholung und Landwirtschaft am Stadtrand).



Registration certification of 'City as Social Habitat' as EXPO project

3.7 CITY AS SOCIAL HABITAT

The 'City as Social Habitat' project was part of the 'projects around the world' Expo competition entry, 'City and Region as Exhibit', and one of the decentral EXPO projects registered by the City of Hannover.

Concept

The 'City as Social Habitat' project aim was to devise approaches and solutions for the conflict situations commonly occurring in a large city, and to apply them through planning strategies. Approaches to social problem clusters in their respective contexts should fulfil universal criteria without, however, presenting schematic off-the-peg solutions. Sub-projects were run at various locations in the city, and three 'City as Social Habitat' sub-projects were implemented at Kronsberg, to be integrated within the overall district social development programme. They were:

- Kronsberg arts and community centre
- the FOKUS sheltered housing project
- the 'Habitat' international housing project

'City as Social Habitat' Projects on Kronsberg

The 'KroKus' arts and community centre is both a meeting place for everyone who lives on Kronsberg and the central forum for the networked community services. In close cooperation with local people, this is where community development work happens, making the connections between social responsibilities, cultural and environmental issues. KroKuS houses the district library, a youth agency, group and function rooms, a large hall, a workshop and a studio.

The fundamental idea of the FOKUS housing project for disabled people who wish to determine their own way of life is an integrated balance of independence and assistance in all everyday activities. The project's specially designed apartments are distributed among ordinary housing but also near a help point.

The 'Habitat' international housing project promotes coexistence between German citizens and immigrant families living as neighbours. A third of the apartments in the complex are reserved for

The 'FOKUS' project: housing for disabled people



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'KroKuS' arts and community centre – the foyer

immigrants, and their groundplans take account of the needs of different cultures. There are apartments of from one to seven rooms plus kitchen and bathroom. Ten percent of the apartments are laid out according to Muslim beliefs and customs. Varied designs for the open space stimulate lively coexistence, as integration should happen through opening up to the outside world.

Planning Instruments

Differentiated financial concepts and rented accommodation and property development subsidies were designed to promote social stability in the district. Of almost 3,000 homes completed so far, around 300 are owner-occupied terraced houses, the rest being publicly-subsidised multiple-occupancy buildings, almost a third of which are subject to a City Council option, that was taken up on Kronsberg, to place tenants from its social housing list. The subsidy programmes defined income levels and new tenancy

bonuses for rented apartments, and building subsidies and first home grants for owner-occupiers, in order to achieve maximum social mix within the district.

In the guidelines for quality assurance in subsidised social housing it was emphasised that communal spirit in the apartment blocks and the establishment of neighbourhoods was to be supported. It was also determined that to supplement the public amenities, 2% of the living space in each block development should be designated for communal use.

These communal rooms in the apartment blocks were built by the developers at their own cost with all main works completed. The City of Hannover then subsidised investment costs for finishing work, while running costs such as rent, electricity, water and heating are the responsibility of independent tenants' associations.

Finances

Construction costs for the Kronsberg arts and community centre were around 14m DM (7.16m €), of which the City of Hannover provided about 6,290,000 € with the remaining 870,000 € coming as grants from EXPO 2000 GmbH, EU-Thermie and the Greater Hannover local government association (KGH).

The FOKUS project generated costs of 5.2m DM (2,658,700 €), most of which was additional expenditure on building apartments for disabled needs (extra space, special equipment and fittings).





'Stadtteilladen' walk-in centre for community services

For this, funding from EXPO 2000 GmbH was used so that costs were not passed on to the tenants. Sponsors could be found for the installation of pioneering communication, building and care technology systems, but costs of assistance and care have to be born by the clients.



'Habitat' – international housing project

Costs of the Habitat project amounted to 24.3m DM (12,424,000 €), financed by the developer through applications for housing construction subsidies. Preparatory studies of construction for intercultural coexistence were funded by EXPO 2000 GmbH with 98,424 €.

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4. Conclusions

The first evaluation on Kronsberg

The Kronsberg settlement in Hannover represents a convincing demonstration of the feasibility of sustainable development in a post-industrial society. Along with a high degree of acceptance among its residents, this positive assessment is based on an independent study that evaluated the planning process and first use phase through an environmental accounting process. The results assign the Kronsberg district, with the concepts applied there, the highest position in any competition between cities for the best urban expansion on a greenfield site. The study confirms that, as an entity, the district represents a successful example of environmentally responsible planning and construction. Consumption of natural resources was minimised and awareness of responsible treatment of the environment and nature could be encouraged.

This positive overall assessment emerged from a comparison of the separate concepts as applied on Kronsberg with current conventional standards and rating the measures according to foreseeable developments. In taking account of future-oriented sustainability considerations the temporal aspects of the assessment acquired particular significance. Overall, the new Kronsberg development demonstrates an above-average high capacity for development. The proof of sustainability on Kronsberg over the next decades will be derived from a combination of the given conditions and the evolving behaviour of the residents.

Assessment of the separate concepts led to a differentiated spectrum of findings. Particular mention must be made of the exemplary ecological soil management programme which alone would secure Hannover a position in the vanguard of settlement development. A comparable rating was assigned to the utilities on Kronsberg. Other concepts such as the energy, water, and domestic and commercial waste management concepts also consistently meet high and advanced standards. Recent analyses of the energy concept have shown that the target of reducing CO₂ emissions by 60 % compared to conventional construction methods for new developments has been achieved.

The basis for successfully implementing the single concepts was the organisation of the planning process itself, which provided the preconditions for differentiation between the separate elements of ecological optimisation. A planning process carefully attuned

to all planning aims set the necessary foundation for sustainable urban development. Right from the design competition stage, no effort was spared to set ecological emphases. All the capabilities and possible influence of urban planning in the fields of pollution minimisation and energy efficiency optimisation were brought to bear through excellent publicity and public relations work. The organisation of this complex planning process achieved, both with regard to the standards applied and their durability, a very high degree of success.

Transferability to other construction projects

The development aim – to design the new city district as an exemplary and visionary community in its urban design, ecological and social aspects – created a need for integrated development planning that involved all the specialist directorates of the city administration at a very early stage. This integrative planning approach and cooperative project development led to effective collaboration that dramatically compressed the time scale for planning and construction procedures. The concept of extended citizens' participation also led to an essentially conflict-free new quality of dialogue between local people and the municipality.

For their implementation, these new approaches needed the standard instruments of land use planning and development planning just as much as the instruments specially devised for Kronsberg, of the urban construction contract, the conditions attached to land sale contracts and the various bylaws. Application of these planning instruments to achieve the high objectives set for Kronsberg was convincingly justified by the results and is thus transferable to future development projects.

The urban construction contact concluded between the municipality and a development consortium for about one-third of the entire area guaranteed the desired housing quality within the defined time scale along with the striven-for ecological quality and participation of the consortium in the infrastructure costs. Sale contracts with private sector developers for municipally-owned land on Kronsberg imposed the 'Kronsberg Standard' on the entire construction area and thus made it possible to enforce it consistently for all constructions. The devised projects also formed the basis of the land sale contracts and thus effectively ensured their implementation. Appropriate conditions laid down in the

development plans facilitated the evolution of many different forms of construction and open space design within the overall urban planning concept. In this way space-saving construction, environmental compensation measures within the development area, on-site rainwater retention and an above-average proportion of vegetation were achieved. The catalogue of planning instruments was effectively extended with special bylaws such as that positing district heating and regulating connection to the decentral CHP plants, or that limiting the proportion of parking space on private land.

These various planning instruments can be applied in many other European cities and communities. The respective local government authority must consider to what extent local political conditions and cultural differences allow application of the individual planning instruments. However, across Europe the proportion of new building compared to the existing housing stock is low – depending on the municipality, not more than 5% in the housing sector. For noticeable short-term improvements to the ecological balance it is thus necessary to include the existing housing stock, and through appropriate planning instruments to strive for the ‘Kronsberg Standard’ here as well.

On the basis of the positive experience with the overall development of the Kronsberg project, Hannover City Council has recommended ecological standards for energy, soil, nature con-

servation, waste, water and building materials, to apply to the entire local government area. In Hannover, efforts will be made to find cooperative solutions, for example within urban construction contracts. Already, when purchasing land from the local authority, purchasers commit themselves through conditions in the contract of sale to building to Low Energy House standards comparable to those applying on Kronsberg. By setting ecological construction standards for buildings within its sphere of influence, the City Council has met another of its obligations within the Agenda 21 process. These standards may be applied without reservations in all German municipalities. Many technical aspects of ecological optimisation and planning instruments can also be applied throughout Europe, as they can easily be adapted to local climatic conditions.

Practical pilot projects such as Kronsberg and dissemination across national borders of the experience gathered there will be the basis for the holistic implementation of complex ecological objectives in Europe. Only intense dialogue and exchange of experience can prepare the way to overall European sustainable development.

LAND SALE CONTRACT

The clauses relating to building insulation in the land sale contract were:

Unless the applicable insulation regulations require higher standards, buildings on Kronsberg must meet the Low Energy House standard (heating energy index of 50 kWh per m² and year as a target value according to the Kronsberg calculation method derived from the State of Hesse guidelines on energy-conscious building planning; this value may be exceeded by a maximum of 10% (limit value). Calculation and verification of adherence to the heating energy index is governed by the modus set out in Attachment A, which is a part of this contract.

Should technical developments allow better methods of calculating and verifying the heating energy index, with the consent of the local authority an equally effective procedure for checking insulation standards may be used.

The inspection of these conditions will be formally verified by a certificate issued by a qualified engineering bureau commissioned by the purchaser and approved by the local authority. The local authority will draw up and supply the certificates. The purchaser guarantees that the engineering bureau commissioned by him will be allowed to monitor building work on site appropriately.

If, on completion of construction, the purchaser cannot demonstrate adherence to the insulation standards in the agreed form even after improvements and repairs, the local authority is empowered, after a reasonable period of notice, and after ineffective remedial action by the purchaser, to have the faults remedied at the purchaser's expense or, because of the eventual necessary improvements to the district heating plants rendered necessary by the non-adherence to the contractually binding insulation standards and costs thereof, to demand compensation of 5.11 € per m² of floor area for each 2% over the heating energy index limit value, which is to be spent on energy efficiency upgrading of civil amenities to ensure adherence to the heating energy index. Payment is due immediately after verification of deviations from the heating energy index by the engineering bureau commissioned by the purchaser.

The purchaser grants to the local authority unlimited but not exclusive rights to publication of knowledge acquired during the monitoring and verification procedure, so long as these do not impair commercial confidentiality.

The local authority has applied for private and public funding for construction on Kronsberg for the quality assurance and skilling and qualification measures. The local authority will inform the purchaser to all reasonable degree of the known funding conditions which are significant for the method of building and, in the event of receiving funding, apportion part of it for the benefit of the purchaser's construction project.

District Heating Provision

For provision of district heating in the Kronsberg residential area, supply and return piping must be laid into the cellars of buildings and underground to the buildings. The lines should be laid as straight and with as few sharp bends as possible.

The purchaser grants the local authority an irrevocable right to construct, operate and maintain district heating lines on the property and especially in the cellars of the buildings to be erected thereon. The local authority is entitled to convey this right to a third party, commissioned to supply district heating.

APPENDIX 2: PLANNING PRINCIPLES AND DETAILS OF THE LOW ENERGY HOUSE (LEH) CONSTRUCTION METHOD

The majority of parties involved in construction were not at that time sufficiently skilled and qualified in building to the LEH standard, which also entails minimisation of thermal bridges and construction of an airtight building envelope. The following section is directed at this group and intended to familiarise them with the current state of the technology in Germany. Additionally, constant reference is made to how this modern technology is to be applied on Kronsberg in each building

At first glance the Kronsberg buildings look like any other; the district's characteristic architecture is compact and straight-edged as encouraged by the development plans. From an early stage, planners and architects were confronted with demands for high energy efficiency. Thus a district has emerged that not only meets the required Low Energy standards but also offers many different forms of architectural expression. Only in the details does one notice the special features of planning and construction.

Compactness of the Buildings

To achieve the 'Kronsberg Low Energy House Standard', consistent minimisation of conducted heat loss through external building components was essential. By positing high building density, building lines and edges in the development plans, a compact construction method with few projections and recesses was encouraged along with a good volume/surface area ration. The individual envelope surfaces were not specified, leaving architects with scope for choice of which insulation methods the heating energy index (55 kWh/(m² per year) applying to all buildings was to be achieved. The heating energy consumption is calculated by a method specially tailored to Kronsberg conditions. It lays down no specifications for the insulation standards of individual building components, but insulation thicknesses based on WLG 040) were arrived at for the great majority of buildings. These thicknesses will be presented in the following to give a more precise picture of the insulation measures on Kronsberg.



These standards resulted in buildings that have substantially thicker insulation layers in their typical cross sections than required by the 1995 insulation regulations.

External wall constructions (frequently attained values of $U_w \sim 0.22 \text{ W}/(\text{m}^2\text{K})$):

While buildings following the current insulation regulations are erected with around 8-12 cm of insulation in the walls, on Kronsberg thickness of 14-28 cm were necessary. Overall, the following wall constructions have been used on Kronsberg:

1. bonded insulation on masonry or concrete masonry or concrete of 17.5 cm, insulation layer of 14–18 cm, rendering
2. fair faced masonry with cavity insulation: 11.5 cm masonry, 15 cm insulation, 11.5 or 17.5 cm inner shell
3. masonry with insulation layer and external back ventilated façade: 17.5 cm masonry shell, 14–18 cm insulation layer, timber substructure, cladding
4. prefabricated sandwich element with integrated insulation, concrete outer shell and inner shell with up to 15 cm integrated insulation
5. timber construction: post-and-beam clad both sides with wood or plywood, filled with up to 22 cm of insulation material.

Most buildings are of masonry with bonded insulation, as this construction is cost effective even with very thick insulation.

APPENDICES

Appendix 2

Roof constructions [frequently attained values of $U \sim 0.17$ $W/(m^2K)$]:

On Kronsberg there are flat-roofed, gently sloping single-pitched, and gable-roofed buildings. Their specifications are:

1. flat roofs: beam construction e.g. reinforced concrete laid with 24 cm-thick insulation and waterproof layer
2. pitched roofs: full insulation between rafters of 20 cm + 6 cm under the rafters.

Cellar ceilings and components in contact with the earth [frequently attained values $U \sim 0.30$ $W/(m^2K)$]:

In residential buildings the following constructions were used: 12 cm of insulation above and under the components

*Superinsulating bricks
in the base courses*



Thermal Bridges

Thermal bridges raise heating energy consumption, reduce living comfort and in extreme cases bring about damage to the fabric of the building.

With older building stock, less well insulated external components do not constitute a particularly significant heat loss in relation to total energy wastage, but do cause dampness. Extremely low inner surface temperatures, condensation and mould are often the consequences.

With the super-insulated constructions meeting the Kronsberg Standard, however, thermal bridges could cause extra considerable proportional heat loss, and therefore great attention was paid



Balcony floors thermally separated from the façade

to avoiding or at least minimising them in external components. Especially, structural thermal bridges in connections and penetration of the envelope were collated, evaluated and in special cases individually checked. The quantified heat losses were then compensated for with other insulation measures. Quality assurance monitoring also ensured that thermal bridges caused by poor workmanship could be averted.

Actual heat losses through thermal bridges could be calculated on a computer using multi-dimensional heat flow programmes.



1



2

*Measures to minimise
thermal bridges:*

1. Insulation in window reveals
2. Insulation in partition wall

Luckily it is not necessary to analyse all the thermal bridges with multi-dimensional heat flow programmes. Whether a detail constitutes a serious thermal bridge can be established by an experienced assessor without calculation, simply through careful geometrical analysis. For reducing heat loss the following four rules are useful:

- Avoidance – whenever possible, do not penetrate the insulation layer.
- Penetration rule – when an interruption in the insulation layer is unavoidable, the transmission resistance of the material should be as high as possible e.g. cellular concrete or, better, wood instead of normal concrete or sandlime brick.
- Jointing rule – leave no gaps in the insulation at component connection points, lay insulation across the entire area.

On Kronsberg there are numerous examples of these structural principles e.g.:

1. Projecting components are not generally used. Balcony floor plates were thermally separated from the insulated building envelope or erected as freestanding components in front of the façade.
2. Roof parapets and walls in the roof area were decked with insulation.
3. The first layer of masonry in the base was laid with superinsulating stone.
4. Fixing structures that penetrated the insulation were reduced in number and chosen to be of low-conductivity material.
5. Windows were set in, with wide facings around the frames.
6. Components were thermally separated whenever the structural analysis permitted.

Windows

Windows in LEHs should be built for solar gain and minimal heat loss as well as admitting light. The prerequisites for this are low heat loss through the windows, suitable glazing and where possible south orientation and little overshadowing.

The amount of usable solar gain is also dependent on the indoor heat retention capacity and proportion of windows to façade area. Windows making up 65 % or more of a wall area should not be considered, as above this the degree of solar gain exploitation sinks.

The good thermal qualities of the new windows are only noticeable if they are correctly installed. Particularly vulnerable to poor workmanship in this respect are solid constructions of concrete or sandlime brick, as these materials have a high conductivity. If the window is badly set in, its k-value can deteriorate markedly. The important points in setting a window are its positioning in the insulation layer and as much insulation in the facings around the frame as possible.

On Kronsberg, windows with very good insulating properties were installed. While there are constant improvements in glass technology, the frames have remained a weak point. For most construction projects on Kronsberg glass with a U-value of 1.1 was used. Together with a class 1 frame this gave a total U-value for the unit of 1.3. The insulation qualities are very good, but glass with good U-values still has at the moment poor g-values, which are crucial for calculations of solar gain.

Airtightness

The airtightness of the building envelope is becoming increasingly important. Leaky envelopes lead to a number of problems that should be avoided:

- Condensation damage: if a draught comes from outside into the building there is a particularly high risk of condensation collecting in the structure.
- Draughts – a stream of cold air near the leak.
- Cold air sinks, especially on the ground floor. Residents find this particularly unpleasant.
- Higher energy consumption – air passing in or out through leaks does not pass through the heat exchanger if one is installed.
- Draught ventilation does not guarantee fresh air, as it is erratic.

As draught ventilation brings no benefits but significant disadvantages, LEHs must be airtight. The principles of this are:

- The 'Single Envelope' Principle
To achieve good airtightness standards, there must be a consistent concept of the airtight building envelope, the most important feature being a single airtight layer enclosing the entire indoor space.



Air intake slit



Blower door

- Impermeability of the Surfaces
Proven effective airtight surfaces are internal rendering (lime, limecement, plaster and also clay rendering), plywood, hardboard, chipboard and OSB, PE sheeting and other long-term stable plastic sheeting, bituminized felt (fibre-reinforced) and building paper.
- Airtightness around Connections
This is where the planning work must focus.
- Airtightness of Penetrations
The best principle is and has always been to avoid them (ventilation outlets under the roof, installations in the skirting board); often, preliminary sealing can be recommended (e.g. plastering installation walls). Holes in concrete slabs are sealed with mortar or plaster (if applied wet enough). Airtightness and draughtproofing are strictly demanded by the current standards and regulations. Intensive interdisciplinary planning and coordination of all works, and the airtightness test meant that uncontrolled ventilation heat loss was never a problem on Kronsberg.
- Airtightness test: Blower Door measurement according to EN 13829
Checking the actual airtightness of the Kronsberg construction projects was one of the most important quality assurance measures. The test procedure is laid down in DIN EN 13829. The Blower Door, a fan with a flow volume meter, is fitted into an opening in the building to create a test underpressure of 50 pascals. All air that enters the building through leaks is sucked out by the Blower Door and metered as flow volume. The airtightness index is determined by dividing the extracted air volume by the building's interior volume. The index is expressed n_{50} – the air exchange rate at a test underpressure of 50 pascals per hour.

Example: A building has an interior volume of 1000 m³; the Blower Door extracts 500 m³ of air per hour. Thus:

$$n_{50} = 500(\text{m}^3/\text{h}) : 1000 (\text{m}^3) = 0,5 \text{ h}^{-1}.$$

The unplanned gaps in the building fabric (leaks) can be traced with airspeed meters or with thermography; it is also possible to track them to source with artificial mist.

The best time to conduct the test is when the defined airtight layer in the building is still visible and accessible, so that leaks can be remedied easily and cheaply.

Certification of Airtightness

When the airtightness of a building or part of a building is measured, the metered airflow volume at a pressure difference between indoors and outdoors of 50 pascals must not exceed the following values:

buildings with *

natural ventilation (windows) $n_{50} \leq 3,0 \text{ h}^{-1}$

ventilation technology $n_{50} \leq 1,5 \text{ h}^{-1}$

(* related to the heated airspace within the building)

In the Kronsberg development area, the airtightness standards for buildings are set at $n_{50} \leq 1,0 \text{ h}^{-1}$ for buildings with ventilation systems, for buildings with window ventilation at $n_{50} \leq 1,5 \text{ h}^{-1}$, and for terraced houses at $2,5 \text{ h}^{-1}$.

Influence of the surface area / volume ratio on the limit value n_{50}

Air leaks in or out through faults in the airtight layer. The smaller this layer is in proportion to the volume of indoor space, the better the probability that the building has a high airtightness rating.

Ventilation

The purpose of apartment ventilation is to achieve good indoor air quality with minimised heat loss and to be easy to operate.

In residential rooms, windows that can be opened are essential to air the room quickly and thoroughly if necessary – to let in the summer night air or after minor domestic accidents like breaking a perfume bottle or burning the meal. However, for need-adjusted ventilation during the heating period they are not very good.

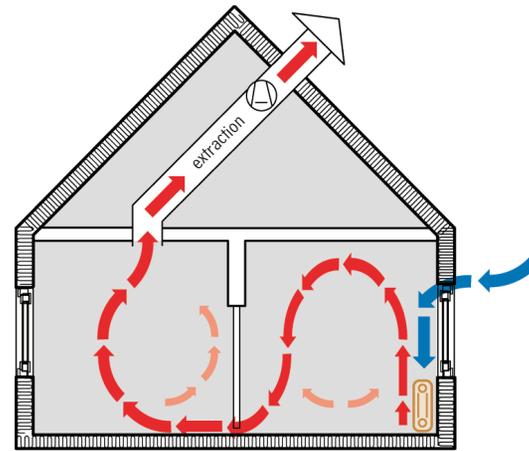
Simple mechanical extractors are suitable for ensuring continuous air change as needed for structural and hygienic reasons. In combination with ventilation grills they provide deliberate and regulated airing of the apartment.

In airtight buildings using heat recovery, the energy consumption for heating can be further reduced. Energy-efficient plants achieve this aim with a heating/electricity production ratio of 5 and above.

On Kronsberg there was no obligation on developers to install controlled ventilation systems. However, it was encouraged by a concession in the calculation method for Low Energy House certification, and almost all apartments and houses were equipped with a mechanical extractor system. For this, a ventilation concept was drawn up and the actual airtightness of the building measured.

The ventilation systems in multiple-occupancy buildings are mostly centralised installations, controlled automatically by humidity sensors. They have adjustable intake slits in the window frames or walls of the living rooms and bedrooms, top flow openings in doors, and extractor grills in kitchens and bathrooms to remove used air.

In installing ventilation systems it is necessary to brief architects and planners about design and layout, and also users about the principles of operating such a system. For architects and planners, workshops were organised and design aids prepared. Tenants were shown how to use the systems at home.



Principle of a ventilation system

EXTRACTS FROM THE QUALITY ASSURANCE FUNDING GUIDELINES

Building at Kronsberg

Guidelines for the Support of Quality Assurance in Low Energy Buildings

Object of the Funding Programme

Within a special programme on the occasion of the EXPO 2000 World Exposition, the City of Hannover local authority encourages the erection of buildings on Kronsberg which meet the specifications of Low Energy House construction, in that it funds the following measures:

1. additional costs of quality assurance measures to achieve the Low Energy House standard in the new buildings
2. costs of additional hot water connections for washing machines and dishwashers.

Low Energy Houses are defined as buildings meeting the requirements set out in Appendix 1.

Appendix 1 to the Guidelines for the Support of Quality Assurance in Low Energy Buildings

1. Verification of Heating Energy Index

Unless the applicable insulation regulations require higher standards, buildings on Kronsberg must meet the Low Energy House standard (heating energy index of 50 kWh per m² and year as a target value according to the Kronsberg calculation method) derived from the State of Hesse guidelines on energy-conscious building planning; this value may be exceeded by a maximum of 10% (limit value). Calculation and verification of adherence to the heating energy index is governed by the modus set out below.

2. In the verification of the heating energy index, the following must be taken into account and/or ensured by planning and construction praxis:

- In allowing for solar gain through glazed external surfaces, not only orientation is to be considered but also shade from neighbouring buildings and evergreen trees.
- Conservatories and other glazed projections that can be considered part of the accommodation are, in verification of the energy index of 50 kWh/(m²*a) always regarded as part of the heat-transferring building envelope and thus to be included in calculations of the heating building volume.

Planning is to be conducted and implemented in such a fashion that, in checking airtightness by means of the pressure-difference method (ISO 9972) the following limit values (mean of over- and under-pressure) are not exceeded:

- terraced house construction without ventilation systems: number of air changes $n_{50} = 2,5 \text{ h}^{-1}$
- multi-storey apartment houses and other buildings without ventilation systems: number of air changes $n_{50} = 1,5 \text{ h}^{-1}$
- buildings with ventilation systems: number of air changes $n_{50} = 1,0 \text{ h}^{-1}$

Verification of insulation standards must contain the following elements:

- location plan with indication of North
- 1:100 scale plan, section, aspect
- heat transition coefficients (U-values) of the building components in the building envelope and sketches of the layers with all relevant data. A single U-value is insufficient!
- diagrammatic presentation of measures to implement the insulation and airtightness concepts
- general ventilation concept
- the completed verification form.

4. Regulations on Inspection and Verification of Construction Work

The subsidy recipient will supply the commissioned quality assurance inspectors with a construction schedule. Significant changes to the schedule must be notified to the inspectors in good time.

The subsidy recipient will allow the commissioned quality assurance inspectors to verify that the airtightness limit values of the buildings meet the regulations. The test should if possible be carried out at a point in the schedule when the building cladding has not yet been affixed and repairs and remedial sealing work can be carried out more cheaply. Airtightness must be checked in every building, and every effort must be made to check the airtightness of the entire building. If overall measurement is impossible because of the construction sequence or other reasons, at least one third of all apartments must be checked. The commissioned quality assurance inspectors must be allowed, at the subsidy recipient's expense, to carry out checks in other apartments if the sample checks reveal defects. The results of the airtightness test must be documented.

The subsidy recipient will allow the commissioned quality assurance inspectors to make at least sample checks on heating technology workmanship in every building.

The subsidy recipient will ensure that the insulation material used is marked with its calorific conductible group in such a way as to be easily identifiable on site. On windows and glass doors, the kV-value and the overall energy transfer value (g-value of the glazing) must also be visible after installation (at least until final inspection by the quality assurance inspections).

The subsidy recipient will inform the commissioned quality assurance inspectors in good time of the contact person and site supervisor for each construction phase.

The subsidy recipient accepts that the commissioned quality assurance inspectors will inform the local authority if, within the scope of the regulations, the required plans are not presented or presented late, or if defects identified during inspection are not rectified.

If a mechanical ventilation system is installed in a building, the subsidy recipient will ensure that the commissioned quality assurance inspector verifies that the minimum requirements for mechanical air extraction or, where appropriate, for a ventilation system with heat recovery are met. This also applies to the installation with regard to thermal bridge effects and the minimisation of air leaks.

The subsidy recipient will ensure that the availability of extra hot water connections for washing machines and dishwashers is checked and documented by the quality assurance inspectors.

The subsidy recipient will have the quality assurance inspectors verify and document that no air conditioning systems are installed in apartments or offices.

The subsidy recipient will inform the local authority immediately if, on inspection of workmanship, deviations from the original plans or defects are identified and not remedied on demand.

The subsidy recipient will have the commissioned quality assurance inspectors complete a report form for the local authority on completion of the work.

The subsidy recipient will commission the quality assurance inspectors to take part in regular consultations with other quality assurance agencies and the local authority during the inspection period, to resolve controversial applications and define consistent assessment criteria.

EXAMPLE OF A QUALITY ASSURANCE CERTIFICATE

EXPO 2000 Quality Assurance, Low Energy House Standard on Kronsberg

Property: New residential complex on Kronsberg in Hannover, Block Nord

Inspectors:

Client:

Architect:

CERTIFICATE 2

Detail Planning and Construction Block Nord

Preliminary Remarks:

The Nord construction block is a residential complex of 13 units, partly adjacent in the same building.

Verification of the insulation standards was carried out within stage 1 of the quality assurance procedure for each building.

For	<i>Stage 2</i>	<i>Inspection of detail plans</i>
	<i>Stage 3</i>	<i>Inspection of construction</i>
	<i>Stage 4</i>	<i>Checking airtightness</i>

a certificate is issued for the entire construction block.

This procedure seems reasonable as the construction type, detail plans, materials used and dimensions of the layers relevant to heating technology are identical for all 13 units.

The following description thus applies without reservations to all separate buildings.

STAGE 2: INSPECTION OF DETAIL PLANNING

The basis for the inspection within the quality assurance inspection was the detail plans of the Dr Sprenger architectural bureau. Inspections verified agreement of the plans with the requirements of the 'Kronsberg Guidelines', the final plans and the methods of proving insulation standards.

Most of the detail plans had already been presented for inspection of insulation standards (see Certificate 1).

At that stage the details of the building envelope with regard to avoidance / minimisation of thermal bridges and measures to achieve the required airtightness in the structures and their connections had been checked.

Certain special points were presented at a later date after issuing of the first certificate. These were also inspected and – where necessary – altered in consultation with the client and architects.

In this connection mention should be made of alterations in the cellar plans. In the ground floor, structural requirements dictated that some walls should not be of masonry – as originally planned – but of reinforced concrete, so that construction of the base with an insulating base course would not be possible. In consultation with all parties it was agreed that the cellar and ground floor layouts were so arranged that instead of c. 50 metres of reinforced concrete only around 12 metres, mainly in the area of pilings bearing heavy loads, were constructed. In the area of the unavoidable reinforced concrete and piles, the cellar ceilings were given extra insulation (6 cm). This averted thermal bridge effects of significant magnitude.

In some lofts, internal walls with a thickness of 10 cm were planned. Deviating from this, they were to be built 11.5 cm thick. The consequent reduction in floor area in the buildings affected was around 0.5 m². This marginal alteration was disregarded in the insulation certification.

Other alterations of significance or relevance to the heating technology between general plan and detail planning were not found. After incorporation of the required alterations, the detail planning met all the essential requirements of the 'Guidelines for Funding of Quality Assurance for Low Energy Houses' as laid down by the City of Hannover local authority.

STAGE 3: MONITORING OF CONSTRUCTION ON SITE

Construction work on Block Nord began in summer 1998 and lasted (including work on the grounds) until the spring of 2000. Construction praxis in areas relevant to thermal efficiency was inspected with regard to its agreement with the detail plans. For this, in the period September 1998 - November 1999, a total of 30 mainly unannounced site inspections were made by the quality assurance inspectors. During these site visits the conductivity and thickness of the insulating materials was sampled, and the quality of workmanship continually monitored.

To ensure good workmanship, on 20 January 1999 a craft trade induction was held on site. All important trades were present (windows, heating, sanitary plumbing, electricians, dry lining and roofing).

At this event the quality assurance inspectors outlined the overall aims and special characteristics of the Kronsberg district. Construction principles to attain airtightness were presented on transparencies and with examples. Specific problems were identified during a tour of the site and possible solutions discussed.

During the site inspections, spot checks were made on materials through inspection of delivery notes and the identification marks on the delivered trusses.

The following materials and components relevant to heating efficiency were used:

Windows:	frame section: Brüggmann plastic frames, Series 81, RG 1, $k_R = 1.6$ listed in 'Bundesanzeiger' (federal gazette) 06.03.98 glazing: Climaplust VKR, air gap 12 mm, $k_V = 1.1$ g = 0.58 IFT Rosenheim, inspection report No. 402 16109/3
Walls WDVS	surface: PS rigid foam, manufacturer GSH 1304, WLG (heat transmission coefficient) 035, 190 mm thick certificate Z - PA - III 2.1001 lintels: G + H ribs, Sillatherm L, WLG 040, 190 mm thick certificate Z - PA - III 4.3B
Wall facings:	mineral fibre, URSA KDP 2/V, WLG 035, 150 mm thick certificate Z. 23.12 - 130
Wall base	KS-Iso-Kimmstein, $k_m = 0.28$ W/(m ² *K)
Balcony	MEA-Iso-bearer, $k_m = 0.60$ W/m ² *K certificate L 1 - 92/93, PA - III.2.1001, type approval by Büro Prof. Rojek, 18.12.96
Roof	between rafters: felt Thermolan Ti 140 U, WLG 040, 2 x 120 mm thick certificate Z - PA - III 4.284 under rafters: Rockwool RP-TW, WLG 040, 40 mm thick certificate Z - PA - III 4-29
Cellar doors	Hörmann T 30-1 H3D, $k = 1,7$ W/(m ² *K) manufacturer's information

The simple extraction controlled ventilation concept used components by the Aereco company. Installation agreed with the plans. On completion of construction a hydraulic comparison was carried out in all buildings to check the functions and regulate the flow. The documentation is available.

Ventilation: System Aereco

supply air: ZFA 01 - 04, humidity controlled

exit air: AH 68 - 75, humidity controlled

filter: AFR 01

During the construction phase there were the following alterations from the inspected detail plans:

- In the roof, calculation of the k-value in the insulation certificate for 11 of the 13 blocks mistakenly used a heat transmission coefficient of the insulation material of WLG 035. The k-value was recalculated with WLG 040 and the alteration taken into account for the 11 single certificates. The annual heating demand thereby rose in these buildings by 0.2 – 0.3 kWh/(m²* a).
- The backed-up masonry of the external walls was constructed, deviating from the plans, not with sandlime brick ($\rho = 1600 \text{ kg/m}^3$, $\lambda = 0.79 \text{ W/(m}^*\text{K)}$) but with honeycomb brick ($\lambda = 0.50 \text{ W/(m}^*\text{K)}$). This alteration was made not at the insistence of the quality assurance inspectors but at the wish of the contractor. The resulting improvement in the k-value was not taken into account in the insulation certificate but reckoned against minor deficiencies at other points.
- For the thermal separation of the balcony floor plates, originally insulated sockets (Iso-Körbe) from the Schöck company ($k_m = 0,438 \text{ W/(m}^2*\text{K)}$) were intended to be used. For reasons of economy a product from the MEA company were finally used ($k_m = 0,60 \text{ W/(m}^2*\text{K)}$). The calculations for verification of houses Nos. 9, 11, 27 & 29 had already been completed when this decision was taken. These thus have the slightly better k-value of the Schöck product. Because of the marginal effect on the overall figure ($< 0.2 \text{ kWh/(m}^2*\text{K)}$) the already completed certificates were not altered. For the remaining 9 single certificates the correct k-values were entered.
- With the bonded insulation for the exterior walls, for fire safety reasons in the lintel area above the windows a 25-cm high strip of insulation class A 2 had to be fitted. According to the supplier, such insulation was not available with a WLG of 035, and a product with WLG of 040 had to be used. The resultant worsening of the average k-value of the exterior wall was not taken into account. A transfer calculation revealed that the worse insulation was more than compensated for by better thermal qualities of the backing wall so that there was no fear of negative consequences for the annual heating consumption.

Other noteworthy deviations between planning and construction were not found.

The overall quality of the construction work was irreproachable

APPENDICES
Appendix 4

For the installed main building components the following k-values were established (in $W/(m^2 \cdot K)$)

Building component	calculated estimate	actual
Exterior walls, fair-face masonry	0.203	0.196
Exterior walls, WE bonded system	0.171	0.167
Cellar walls (stairwell)	0.395	0.395
Single-pitch roof	0.139	0.153
Cellar ceiling	0.207	0.207
Roof terrace	0.259	0.259

Taking into account the significant alterations between planning and construction, the following values for annual heating energy consumption were calculated:

House No..	heated living space (m^2)	$Q'_{H,old}$	$Q'_{H,new}$
	965.35	55.69	55.99 kWh/($m^2 \cdot a$)
	965.35	55.69	55.99 kWh/($m^2 \cdot a$)
	861.17	53.28	53.28 kWh/($m^2 \cdot a$)
	745.10	52.63	52.63 kWh/($m^2 \cdot a$)
	743.00	53.93	54.25 kWh/($m^2 \cdot a$)
	710.11	50.02	50.27 kWh/($m^2 \cdot a$)
	946.27	51.55	51.88 kWh/($m^2 \cdot a$)
	741.84	50.51	50.81 kWh/($m^2 \cdot a$)
	751.53	51.43	51.77 kWh/($m^2 \cdot a$)
	710.11	50.02	50.27 kWh/($m^2 \cdot a$)
	744.96	52.41	52.63 kWh/($m^2 \cdot a$)
	743.00	54.60	54.92 kWh/($m^2 \cdot a$)
	946.27	52.07	52.35 kWh/($m^2 \cdot a$)

Buildings Nos. ... and ... were slightly ($< 1 \text{ kWh}/(m^2 \cdot a)$) above the required limit value of $55 \text{ kWh}/(m^2 \cdot a)$. This is above all due to the fact that they are detached houses. In all the other buildings the target values were met.

The adjusted mean value of annual heating energy consumption for the entire Block Nord as an economic unit is $52.97 \text{ kWh}/(m^2 \cdot a)$

STAGE 4: CHECKING AIRTIGHTNESS

Preliminary remarks on the measurement procedure:

Measurements to verify airtightness were made using a Minneapolis Blower Door, Model 3. The evaluation of measurements and creation of the measurement record was carried out using the manufacturer's computer software. Measurements were conducted on the basis of recommendations contained in ISO 9972.

The buildings to be inspected were apartment blocks, 3 or 4 apartments on each landing, with a closed volume of between 1,790 and 2,450 m³ on each staircase. Thus all the apartments on one staircase could be checked in one test.

During the measurement the air change rate n_{50} (h⁻¹) at 50 pascals pressure difference was measured with under- and over-pressure conditions.

Separately from the measurement result, sample checks were made in constant underpressure conditions to find typical leaks. Thus attention was drawn several times to:

- leaks around cellar doors (remedied by adjustment)
- leaks in large window- and door elements (remedied by adjustment)
- leaks around the bases of floor-to-ceiling window and door elements (faults in the joints between facings and bare floors around the mounting angle, poor adhesion of the sealing compound because of dust)

As the buildings are equipped with an extraction ventilation system, the air change rate limit value of $n_{50} < 1.0$ h⁻¹ had to be observed.

Overview of the Results

House No.	Date	mean value n_{50} (h ⁻¹)
	29.03.99	0.71
	17.05.99	0.60
	29.11.99	0.94
	29.11.99	0.98
	07.09.99	0.80
	07.09.99	0.72
	17.05.99	0.73
	07.09.99	0.63
	17.05.99	0.86
	07.09.99	0.84
	29.11.99	0.90
	07.09.99	0.79
	29.11.99	0.81

The measured air change rates n_{50} for every building lie below the required limit values. The mean value of all buildings is 0.79 h⁻¹, with a range of 0.60 to 0.98 h⁻¹. Repeat measurements were thus unnecessary.

After the relatively poor performance of houses No.... the following remedies were effected.

House No. ...

On the day measurements were taken, the communal room in the semi-basement was not yet in a condition to be tested. Completion had been delayed as the final use of the space had not been clear for a long time. This part of the building was therefore excluded from the test.

This situation, however, caused a series of faults in the area of conduit, pipe and cable breakthroughs between the staircase and the communal rooms. On completion of the building these breakthroughs would lie within the heated interior and would thus not need to be sealed. The temporary seal for the test could not be effected properly. Also, on the staircase a walled-up door opening had not yet been plastered. At this surface, too, there was a noticeable draught and temporary remedies could not be applied in time.

The window and door casings in the entire house had not yet been adjusted.

Despite these known deficiencies the measurement was carried out. It can be assumed that the subsequent building process and routine finishing work will bring about an improvement in the airtightness standard.

House No. ...

Here a double-opening casement window on the staircase could not be closed properly. To carry out the measurement the windows had to be held closed with a prop pressing them against the frame.

On the cellar stairs the floor tiles had not yet been grouted. Through the open gaps between tiles there was a draught across the threshold of the cellar door.

In the course of an inspection tour it became clear that a series of seals around extractor vents made by the contractor showed signs of damage from careless subsequent work. Sealing was, because of the dampness of the surrounding area (painters' work), impossible.

It must be assumed that these leaks had a negative effect on the results. Through the subsequent building process and routine finishing work an improvement in the airtightness standard can be expected.

House No. ...

Here, the cellar doors were particularly leaky. The necessary adjustments could not be made during the test. After remedying these faults the airtightness standard should improve here too.

Overall Results of Quality Assurance Monitoring

The 13 residential buildings on Block Nord, constructed by the firm xxx, were tested in a four-stage procedure according to the 'Guidelines for Quality Assurance in Low Energy buildings'.

For each of the four stages, the necessary certificate could be unconditionally issued.

APPENDIX 5:

Bylaw governing District Heating Provision in the Kronsberg Construction Area, City of Hannover

By virtue of the powers invested in it by § 6, 8 and 40 of the Lower Saxony local government law of 22 June 1982 (Nds. GVBl. p. 229), last amended through Article 1 of the law of 09 September 1993 (Nds.-GVBl. S.359), Hannover City Council hereby passes the following bylaw:

§1

Purpose and Subject of District Heating Provision

(1) Hannover City Council strives to protect people and objects within the city area from the adverse effects of air pollution and the negative consequences of climate altering gases. It therefore finds it necessary, in the spirit of preventative environmental protection, to establish low-emission heating provision plants. To this end, Hannover City Council permits a third party commissioned by itself to operate district heating systems as a public service.

(2) As low-emission heating provision plants, mainly gas-powered decentral cogeneration plants are to be installed. Hannover City Council can also permit other forms of heating provision plant, when they fulfil the aims as set out in paragraph 1.

(3) The subject of district heating provision is the delivery of steam, condensate or hot water as the medium to heat rooms, to supply hot water and cooling, with the exception of the use of household appliances.

§2

Area to be covered by District Heating Provision

The area to be covered by district heating provision comprises the properties within the boundaries of the appended plan. The plan is part of the bylaw.

§ 3

Connection and Use Rights

1) Each owner of a property lying within the area defined in § 2 and fitted with operational supply lines is - unless covered by the restriction in paragraph 3 - entitled to demand that his or her property be connected to the district heating network (connection rights).

(2) After connection of the property to the district heating network, the connection user has the right to draw the necessary calorific volume from the supply plant (use rights).

(3) Should, because of the exceptional location of the property or other technical reasons, connection to the network be only possible with considerable difficulty, or should exceptional measures or expense be necessary to connect the property, Hannover City Council may refuse to connect the property and refer the applicant to other energy sources. This does not apply if the applicant declares his willingness to bear, along with the construction cost subsidy, also the necessary extra installation and, if necessary, operational costs. In this case he must provide appropriate financial guarantees on demand. If the reason(s) for refusing connection cease to apply, procedure is governed by the regulations included in this bylaw.

(4) 'The property owner' in the sense of this bylaw is taken to include the owner of an apartment and a lessee.

§ 4

Connection and Use Obligations

(1) Inasmuch as a connection and use right exists, each property owner is obliged to connect the property to the public district heating network (connection obligation). Should there be several buildings on the property in which space heating and hot water are required, each building is to be connected to the network.

(2) In properties connected to the public district heating network, the entire requirement of space heating and hot water is to be drawn exclusively from the district heating network (use obligation). This obligation applies to the property owner, all residents of the buildings and other heat consumers.

(3) In the properties subject to connection obligation, apart from the district heating provision operated as a public service utility, other combustion plants such as heating powered by coal, oil, gas or other fuels that could produce smoke or other fumes, and the installation and operation of electrical heating, are not permitted. This does not apply to open fireplaces in residential building insofar as they are not used for heating the buildings, are only occasionally used and fuelled by untreated wood.

§ 5

Exemption from Connection and Use Obligations

(1) Exemption can be granted from connection and use obligations when heating provision to the property is otherwise effected than with the energy sources named in § 1 paragraph 2 or when connection or use is an unreasonable burden on the property owner, when the purpose of this bylaw is not thereby endangered, the common good is respected and provision of district heating to the remaining users is not impaired.

(2) Exemption is only granted upon application with justification to Hannover City Council. In the case of use of heating provision plants for the property other than those defined in § 1 paragraph 2 it must be proved that the alternative will not cause more air pollution and emit more climate altering gases than would be the case with connection to the district heating system.

(3) Exemption from connection and use obligations is subject to revision or for a fixed period. It may be granted conditionally or with additional obligations.

§ 6

Connection and Use

1) Connection to and use of the district heating network is governed by civil law contracts between the property owner and the third party provider commissioned by Hannover City Council according to the general regulations for district heating provision of 20.06.1980 (AVBFernwärmeV, BGBl. p. 742 ff), last amended by the order of 19.01.1989 (BGBl. I S.109) to amend the energy saving statutory regulations and extended rules on district heating provision. The model contract and extended conditions for district heating provision are determined between Hannover City Council and the third party provider(s).

(2) Each property owner obliged by Hannover City Council to connect to the district heating network must immediately apply to one of the third parties commissioned by Hannover City Council to conclude a supply agreement according to paragraph 1.

§ 7

Breaches of the Law

Whoever deliberately or through negligence acts against the regulations in § 4 of this bylaw is deemed to be in breach of the law according to § 6 paragraph 2 NGO. Such a breach may attract penalties not exceeding 10,000 DM.

§ 8

Effective Date

This bylaw comes into force on the day after it appears in the gazette for the administrative district of Hannover.

Hannover, 4 December 1995

APPENDIX 6:

Environmentally Compatible Building Materials

Chemicals are often widely used in the production of materials for building components or in the building materials themselves. The effects of many of them on human health and the environment have not been adequately investigated. Furthermore, any building material, whatever its good qualities, will compare badly with an alternative in some aspect or other. Nevertheless, some chemicals can be clearly identified as undesirable in the sum of their effects on health and the environment over their entire life cycle when compared to alternatives for the same purpose. What follows is a list of building materials and chemicals that should not be used at the Kronsberg development, along with examples of ecologically preferable alternatives.

1. Extensive avoidance of chemical preservatives for wooden building components.

Chemical wood preservatives applied as fungicide and insecticide contain active ingredients that can be harmful to health or the environment. Until the early eighties pentachlorophenol (PCP) and Lindane were used. Today the principal active ingredients are inorganic salts, pyrethroids and dichlofluanides.

Boric salts are generally safe for the environment and human health, but can easily be washed out, polluting soil and ground water. Controversy has arisen about production and disposal processes. Salts of chromium, arsenic and copper are regarded as environmentally incompatible but are used just as often as compounds such as CFB - chlorofluoroboron salts.

Pyrethroids are insecticides, a synthetic imitation of the pyrethrum flower poisons, well known under trade names such as Permethrin. Their environmental compatibility has been disputed for many years - assessments range from environmentally safe to carcinogenic and reducing fertility according to the USA environmental agency.

Dichlofluanides are fungicides used in solvent-based wood preservatives. They can cause irritations, provoke allergies and are suspected of causing cancer and infertility.

The German chemical industry association estimates that there are currently 2,000 – 2,500 wood preservatives on the market, 90% of which are approved neither by the Institute of Building Technology nor by the RAL wood preservative standard.

In many cases, wooden building components do not need protection by chemical preservatives. This is demonstrated by many old buildings with their well-thought-out structural features: canopies, roof overhangs, coverings, draining edges, rear-ventilated cladding, protected base points of metal or stone, heartwood in vulnerable areas, beam supports accessible for inspection and visible and accessible roof constructions. These old techniques are increasingly being rediscovered and applied, even when some details such as oversizing and the exclusive use of heartwood or hardwoods is seldom economically viable.

In the old version of German Standard DIN 68800 (wood preservatives in buildings) chemical preservatives were strictly stipulated in almost all areas. The current (since 1990) version reflects recent developments that allow developers freedom of choice but also demand a sense of responsibility for their choices. Section 3 of the standard introduces the new vulnerability class 0, in which chemical preservatives are not required. This class can be applied to all internal areas of residential accommodation, even for load-bearing components, for attic extensions and in some cases for wet areas through constructive solutions and selection of suitable varieties of timber.

Derived from DIN 68800 (section 2, construction wood preservatives, new version, 1996) and collated with current research findings, one can set out the following principles and recommendations:

- In living rooms, wood preservatives may be dispensed with, especially if the wood is visible but protected or roofed over. Condensation prevention measures must be applied.
- Load-bearing timbers can be installed without chemical preservatives if they are either fully cladded or accessible for monitoring.



- In wet areas (kitchens, bathrooms etc.) the choice of varieties of timber, suitable construction techniques such as rear ventilation and surface protection e.g. waxing will make the use of preservatives generally unnecessary.
- In external areas chemical preservatives can generally be dispensed with:
 - if there are sufficient structural measures to provide permanent protection against weathering (cladding, roof overhangs)
 - by using suitably resistant varieties of timber e.g. robinia, oak, larch, Douglas fir or parts of the tree e.g. heartwood.
 - by avoiding the use of wooden construction elements in permanent contact with the earth or water (vulnerability class 4)

2. Avoiding the use of tropical hardwoods for construction elements

The threatened annihilation of the tropical rain forests with serious consequences for the global climate has brought about a change in public attitudes to the use of tropical hardwoods. In 1989 the City of Hannover passed a resolution to use no tropical hardwoods in any new construction project. It follows that such use in the new Kronsberg development is prohibited because there is currently no objectively assessed and recognised certification of origin from renewable plantations.

areas of application	suitable European timber varieties
garden furniture, posts, fences	pine, larch, oak, robinia
window frames, doors, façade cladding	larch, pine, oak, spruce
wall cladding, profile	maple, beech, oak, alder, spruce, pine, cherrywood, larch
sauna	poplar
parquet flooring, floorboards	maple, birch, beech, oak, ash, spruce, larch
wood trim	maple, beech, spruce, pine
furniture	all indigenous timbers

In all applications, tropical hardwoods can easily be substituted by indigenous timber; for all external uses there are resistant European timber varieties, and internal areas can use the entire range of indigenous timber.

3. Prohibition of building components or materials containing asbestos, PCB, PCP or Lindane

Production and use of building components or materials containing such substances as asbestos or PCBs is prohibited in Germany. Nevertheless, they still reach the German market as imports, partly on the official European trading systems, and so extra vigilance is needed to check that there are no health-endangering ingredients.

Asbestos is a general term for a variety of minerals that occur naturally, mainly in Canada, Russia and South Africa. They contain silica, are fibrous, do not burn and are resistant to chemicals and heat. Asbestos was included in over 3,000 products in the building trade alone: in sealing materials, insulation, sheathing paper, cement slabs and pipes, extruded profiles, as additives for floor coverings, bitumen, grouting and window sealants. Production of building products containing asbestos has been prohibited since 1991 and their use prohibited since 1992. A list of alternatives has been drawn up by the federal health and safety at work authority and is available from the City's Environmental Protection division. The register of hazardous substances rates asbestos as carcinogenic – the fibres can lodge in the lung tissue and, decades later, lead to cancer of the lung and rib lining (mesothelioma), as well as asbestosis, which is caused by long-term inhalation of asbestos dust in production plants and leads to bronchial cancer.

PCB (polychlorinated biphenyl) is the collective term for a mixture of synthetic compounds from the group of chlorinated aromatic hydrocarbons. According to the register of hazardous substances they are injurious to health and environmentally hazardous with a danger of long-term build-up in ecosystems, being extremely poisonous for water organisms. In the German 'MAK' list of maximum permissible workplace concentrations they are rated IIIB – confirmed suspicion of carcinogenic potential. A risk of reduced fertility cannot be excluded even if the MAK limits (0.5 mg/m³) are adhered to. The production of PCBs involves unavoidable contamination by furane and dioxins. They break down very slowly,

accumulate in the food chain and damage the liver, kidneys, spleen and stomach.

PCBs are used as softening agents in jointing compounds, fireproof coatings, in formwork lubes, plastics and cable insulation. They were also found in closed systems such as condensers in fluorescent lights, coolants and hydraulic fluids. PCBs have not been produced in Germany since 1983, and their sale and use has been prohibited since 1989 (PCB prohibition, 1993 amendment to the hazardous substances regulations). A list of alternatives is available from the City's Environmental Protection division.

PCP (pentachlorophenol) is also one of the chlorinated hydrocarbons. It is rated as carcinogenic and the most toxic and dangerous of the group. Its production is contaminated with furanes and dioxins. Because of its wide use and longevity it is found everywhere; people are bound to come in contact with it. PCP attacks the human immune system and leads to cirrhosis of the liver, deterioration of the bone marrow and damage to the nervous system. It was widely used as a fungicide in wood preservatives, paints, adhesives, sealing compounds, grouting and pipe jointing compounds, in disinfectants and food preservatives and in the paper, textile and cosmetics industries. The production and sale of PCP has been prohibited in Germany since 1989.

Lindane is the trade name for gamma-hexachlorocyclohexane (-HCH) and also belongs to the chlorinated hydrocarbons. Lindane is an insecticide, deadly in the finest of dosages. In humans it leads to serious poisoning (MAK value 0.5 mg/m^3 and has been added to the register of particularly environmentally suspect pesticides. The possibility of carcinogenic effects is being examined.

Lindane causes damage to the liver and kidneys and disruption of the central nervous system, and can accumulate in the food chain. Its use in Germany is permitted only with strict reservations. One must be aware that it could still be used as an agent in wood preservatives and medical products.

4. General avoidance of construction elements made of aluminium.

Aluminium is a widely occurring chemical element (Al) and the most important of the light metals, being a good conductor with

excellent mechanical qualities such as corrosion resistance and durability. Aluminium is highly resistant to many substances but susceptible to attack by chlorine, alkalis and concentrated acids. In building construction it is used for façades, windows and doors, load-bearing elements, lightning conductors and roofing.

Its production from bauxite ore requires a great deal of electrical and mechanical energy – 15 kWh per kg of aluminium are required for smelting flux electrolysis alone. There are further environmental disadvantages: the production waste, red mud, creates a problem and most of it goes to landfill. Emissions such as carbon monoxide, sulphur dioxide, aluminium dust and fluorine compounds are also not insignificant. Furthermore, bauxite processing requires long transport distances and consumes large areas of land. Anodising of the surface to improve corrosion resistance requires a further 5 kWh/m^2 and creates environmentally serious hydrocarbons and slurry.

In recent years the aluminium industry has taken measures on recultivation of mined land, soil and water management, uses for red mud, reduction of energy demands and recycling. Aluminium recycling is very viable: about 95% less energy required, lower emissions – although every tonne of secondary aluminium creates 0.4 tonnes of salt slag whose clay component must go to landfill.

Aluminium can be substituted in many cases by other materials of comparable price (see table), although there is as yet no satisfactory substitute for cladding subframes. Exemptions for small components and those under exceptional stress must be cleared with K/2000 at the City's Environmental Protection Division.

aluminium application areas	model alternatives
facade cladding	stone, metal, fibreboard
window and doors	wood, steel, halogen-free plastics
load-bearing components	steel, reinforced concrete, wood
roof gutters and downpipes	zinc sheeting, copper, stainless steel
lightning conductors	copper
roofing	roof tiles

5. Prohibition of building components and materials containing CFCs

CFC is the common term for chlorofluorocarbons. They are chemically and thermally very durable, non-inflammable and virtually non-toxic. Since 1974 it has been known that CFCs destroy the ozone layer and thus reduce the UV filter enclosing the earth to a dangerous degree, raising risks of skin cancer. They also contribute to the greenhouse effect.

CFCs are mainly used as propellants in spraycans and the production of foam, as refrigerants for cooling equipment, heat pumps and air conditioning and as foaming agents for plastics. The 1991 CFC-halon prohibition order demanded graduated phasing out of certain CFCs and halons for some applications by the year 2000. For most applications CFCs have been replaced by other propellants such as the hydrocarbons propane and isobutane, carbon dioxide and part-halogenated hydrocarbons. Even though there is as yet no prohibition of part-halogenated hydrocarbons because of their environmental effects the use of foam products whose manufacture requires them should be avoided.

6. Exclusion of construction elements and materials containing formaldehyde

Formaldehyde is an acrid-smelling gas (known as formalin in a water solution); long-term exposure causes allergic reactions and lung damage. There is a justified suspicion that it causes cancer (confirmed in animals, section IIIB on the MAK list of hazardous substances). It is economically important (tens of millions of tonnes produced worldwide). It is mainly used as a binding agent in the manufacture of wood products, mineral wool insulation and plastics, appears in flooring and carpet adhesives, parquet sealing compounds and as a preservative in cans of paint and varnish. In addition, formaldehyde is used as a disinfectant and preservative and in the cosmetics, textile and paper industries.

For indoor concentrations the 0.1 ppm limit set by the former federal ministry of health has applied since 1977, but this is generally regarded as too high. For chipboard the emission class E1 (<0.1 ppm) applies, and since 1989 wood products containing formaldehyde must meet the E1 quality standard. Awarding of the environmental seal of approval (RAL-UZ 38) certifies that emissions are less than 0.05 ppm. Alternatives are formaldehyde-free

chipboard labelled F0. These alternatives are only environmentally compatible when the binding agents are also environmentally compatible, containing e.g. Lignin or cement.

7. Exclusion of construction materials which could release Isocyanate.

Isocyanate (MDI) is produced in a chemical process using toxic substances such as phosgene to manufacture polyurethane (PU or PUR). Isocyanates are harmful to health; the MAK limit is just 0.01 ppm, one of the most stringent on the MAK list.

Polyurethanes are used in insulation (rigid foam plastic sheeting, in-situ foam with very low conductivity), sealants, paints and coatings, adhesives, for automobile parts, cushions and mattresses. Insulation boards should meet German Standard DIN 18184-1 and contain no CFCs. Recycling of polyurethane insulation boards is as yet not economically significant. Landfill is difficult because they cannot be compressed.

Polyurethane rigid foam insulation boards are permitted at Kronsberg because of their good insulation characteristics and chemical stability (no isocyanate emissions). PU in-situ foam, however, must not be used because, unlike the boards, the possibility of isocyanate emissions cannot be excluded. PUR in-situ foam is intended for fixing building components but is often used for sealing even though it is not really suitable. Here and for other fixings there are sufficient alternatives such as careful tamping with tow, externally sealing tapes and permanently elastic cork mass that can be pressed in with a cartridge, similarly to the PU process.

8. General exclusion of construction elements and materials containing PVC

PVC (polyvinyl chloride) is a thermoplastic produced in large quantities (1990 – 1.3m tonnes) by the polymerisation of vinyl chloride. Using various additives such as softeners for floor coverings, flame retardants in cables and conduits, lubricants stabilisers, dyes and fillers can give PVC the desired quality. Hard PVC is used for e.g. window frames and pipes, soft PVC for floor coverings. PVC is weather resistant, durable, resistant to chemicals and corrosion, light and easily worked.

PVC application areas	model alternatives
window frames	wood, steel, halogen-free plastics
window and door seals	rubber, neoprene
drinking water pipes	copper, polyethylene, stainless steel
waste water pipes	ceramic, stoneware, cast iron, concrete, polyethylene
cisterns, sanitary equipment	porcelain, metal, polyethylene
gutters	sheet zinc, copper
floorcoverings	linoleum, wood, textiles, tiles, polyolefin
skirting boards	wood
facade cladding	stone, metal, fibreboard
handrails	wood, metal (stainless steel)
cable insulation and sockets	halogen-free plastics
cable conduits	steel, polyethylene (HDPE)
sheeting, thick protective sheeting on roofs, windproofing	polyethylene, sheathing paper, bituminous materials

Vinyl chloride produced during the manufacturing process is carcinogenic, but emissions from the final product are small. The many additives used in the manufacture of PVC create environmental problems (vapour, decomposition side products and heavy metals). Use of soft PVC can release additives; laboratory experiments have identified over 150 ephemeral substances vaporising from PVC floor coverings. When it burns PVC releases chlorohydrocarbons, acid salts and dioxins. Disposal is difficult (there is currently an estimated 7m tonnes of PVC in Germany) because PVC still goes to landfill (a problem with the additives) or is incinerated (controversial discussion of dioxin release). The PVC industry has set up recycling systems that should guarantee to take back and reuse all PVC from window frames and pipes. After polyethylene, PVC is the most important plastic with many and varied applications. In construction it appears, for instance, in window frames, pipes, cisterns, gutters, slatted blinds, floor-

coverings, skirting boards, handrails, facade cladding, cable insulation coatings and sheeting.

Many PVC building products can be substituted by natural materials or halogen-free plastics (see table above). Alternatives are (so far) too expensive in only a few areas. Exemptions, for small components and components under exceptional stress, must be agreed with K/2000 at the City's Environmental Protection Division.

9. Use of mineral fibre products only when no fibre can penetrate to the interior space

Artificial mineral fibres have been the subject of controversy for some time. The German federal health and safety at work authority, the former federal health ministry and the environment ministry have rated dust from mineral fibres as 'substance with a justified suspicion of carcinogenic potential, comparable to grade III A2' on the MAK list of hazardous substances. The mineral fibre manufacturers' association, however, claims that for 60 years there has been no proven connection between mineral fibre and cancer and that the MAK rating is unjustified. Since 1996 the mineral wool industry has changed its production methods. The 'new' products can be recognised by the rating 'KI > 40' (KI = carcinogenic index) which refers to a higher biodegradability of the fibres, and the 'Blue Angel', which indicates that the product meets the RAL-UZ environmental criteria – low biological persistence of the fibres. 'Old' products, from abroad for instance, should not be installed.

The City of Hannover has set preventative regulations for its own buildings and for Kronsberg that artificial mineral fibre products may only be used when it is certain that no fibres can penetrate the interior spaces. With insulation from the outside this condition is met by the construction method; if insulation is installed from within, the mineral fibres must be separated from the interior space by airtight sheeting or boards.

10. Use of coatings, paints and adhesive containing little or no solvents and/or identified as environmentally compatible by the 'Blue Angel' sign

Solvents can damage the central nervous system, liver and kidneys, contain carcinogenic substances and reduce fertility. In addition they are a major contributor to photochemical summer smog. Paints containing 10% solvent or less and adhesives with no more than 5% solvent are rated 'low solvent'.

The 'Blue Angel' seal of approval identifies products that demonstrate relatively good environmental compatibility within their product group. Natural products such as linseed oil cannot be rated. For the paints product group the seal of approval 'RAL-UZ 12a' (environmental seal of approval - low pollution) is awarded.

Compiled March 1998

APPENDIX 7

Kronsberg Advisory Council

Recommendations for Urban Design

Based on the excellent concept from the urban design competition, the land sale announcement for the first construction phase offered examples of the desired urban design parameters. Numerous architects' contributions differed from the general conditions of the land sale offer. The general view of all the contributions presented by the location plan is of a heterogeneous townscape of widely differing qualities. Despite the desired variety of housing forms, materials and colours employed in the structures and open spaces, a homogeneous townscape is the desired result. It is therefore recommended that district architects should be engaged to work closely with developers and architects, which requires ongoing consensus among all parties. The Advisory Council will draw up instructions for this at the next meeting.

With the following recommendations the Advisory Council reminds participants of the urban construction guidelines as set for the competition and the land sale conditions, and puts them in practical terms as derived from the experience gained from the proposed construction concepts.

1. Build to the development edges and street lines!

An important characteristic of the urban development concept is the clear separation of town and countryside. Even with lower density on the uphill side of the Kronsberg development, it is important to set a clear urban boundary. This also applies to construction along the street line. Clear alignments should clearly state the development profile, and consistency demands that corner sites should also be developed.

2. Harmonise development with the topography of the site!

The slope of Kronsberg hill demands differentiated construction forms. Proposals for long buildings crossing the contour show the difficulty of compensating for height differences inside the buildings and the associated use and design problems as well as the high cost of using this form of construction. If long buildings are planned they should run along the contour. If pavilion forms are

planned they should mainly be located along the streets leading up the hill.

3. Create a balanced relationship between building density and usable open space!

The development plan posits differentiation from higher densities along the main access road to lower densities in the uphill area of Kronsberg. In areas of higher density, usable open space such as a communal inner court in residential complexes is particularly desirable. There should be sufficient private open space areas for ground floor and first floor apartments.

4. Street Side Orientation!

All buildings should face the street, above all with house entrances from the pavement. The back of the buildings should have a quiet, semi-public character. Entrances at the rear of the houses should be avoided.

5. Design inner spaces!

The centres of the block developments should be for communal use, accessible for residents and visitors through narrow pathways from the street, although they should mainly respond to the private and communal interests of the residents. The communal open space should be close to and easy to reach from home. These internal spaces can constitute an independent, secluded net across the residential district without, however, being regarded as public thoroughfares.

6. Create a water concept!

The requirements for a water concept are included in the land sale announcement. They provide for infiltration of surface water and securing the water resources balance. Usable open space area must therefore be larger than the area needed for rainfall infiltration. Directing run-off across the slope creates better infiltration conditions. Watercourse design places high demands on the open space concept.

7. Integrate parking spaces!

Private parking spaces should mainly be located within the development plots. Planning can assume a ratio of 0.8 of a parking space per home within the site. If underground garages are intended they should mostly be located under buildings, not beneath the communal inner court. The concept for underground garages should allow staged construction on the plots. Concepts for parking spaces set into the slope seem interesting, but they could lead to very long garage rows along the open space. A favoured option is surface parking between buildings exploiting the topography. The number of access roads is limited in the development plan.

8. Elaborate a typology of dwellings!

Various orientations to the neighbourhood, sunlight, gardens and parking spaces suggest different types of construction plans. Communicative forms of access and services, high quality open space and a variety of types are indispensable. Another interesting style is the arrangement of clusters of buildings around small courtyards. Experimental house building should not happen in isolation but should be self-evidently part of the entire concept.

9. Encourage provision of community rooms!

Areas and spaces for individual or communal use have been included in only a few concepts. Especially the ground floors of the corner buildings offer themselves for communal use, but simple buildings in the inner courts for residents' joint use are also desirable. Possible development for other uses at a later stage should be left open. It is also desirable to build communal rooms whose purpose cannot yet be defined.

10. Guarantee divisibility!

An interrelated block development by several developers and architects must also be possible. All designs must then offer ways of dividing up the construction work sensibly.

APPENDIX 8

SUMMARY CO₂ AUDIT FOR 1999 – 2001

Targets and Results at the Hannover Kronsberg EXPO Settlement

The City of Hannover's objective for the Kronsberg EXPO settlement was to reduce CO₂ emissions by 60% compared to conventional new buildings before the new energy-saving regulations came into force on 1 February 2002 i.e. according to the previously valid insulation regulations from 1995. This target was to be met by, among other measures, an energy efficiency quality assurance and skilling programme, Low Energy House building methods across the entire development, district heating provision from decentral CHP plants and an electricity saving programme. Another 20% of the harmful gas CO₂ was saved by building passive houses, solar powered district heating, microclimate zones, photovoltaic installations and wind turbine generators rated at 1.8, 1.5 and 0.3 MW respectively.

The data collected by the Heidelberg ifeu – Institut for 1999, 2000 and 2001 show that these measures have worked. From the monthly energy consumption of all apartment buildings on Kronsberg it could be demonstrated that the high initial losses in 1999, which had disconcerted some residents, had to a great extent disappeared by 2000. The findings of these surveys are summarised and interpreted in the following.

Initial losses soon disappeared

In the 1999 survey the majority of buildings had unexpectedly high energy consumption levels. By comparing the monthly energy consumption with data on the occupiers this development could be explained. In the first months of occupation of most buildings the heating index was higher than when the buildings were fully occupied. The reason was, for example, that while the interiors of the apartments were being completed the radiators in the rooms were on all the time, even at weekends, to speed up the drying-out process. The expected low heating index could thus only be achieved when the buildings were completely occupied and the residents themselves controlled their heating and ventilation.

EXPO apartments also meet the high standards.

In 2001 the apartments used as EXPO 2000 personnel accommodation were included in the audit for the first time, extending its range from around 1,700 to around 2,900 homes and a total living space of approx. 212,800 m². At the end of 2001 there were 6,475 people living on Kronsberg who had used about 20,200 GWh of heating energy and about 6,400 GWh of electricity in the course of the year.

As in 2000, in 2001 there were no more significant system losses, and a stable basis for the audit is now available.

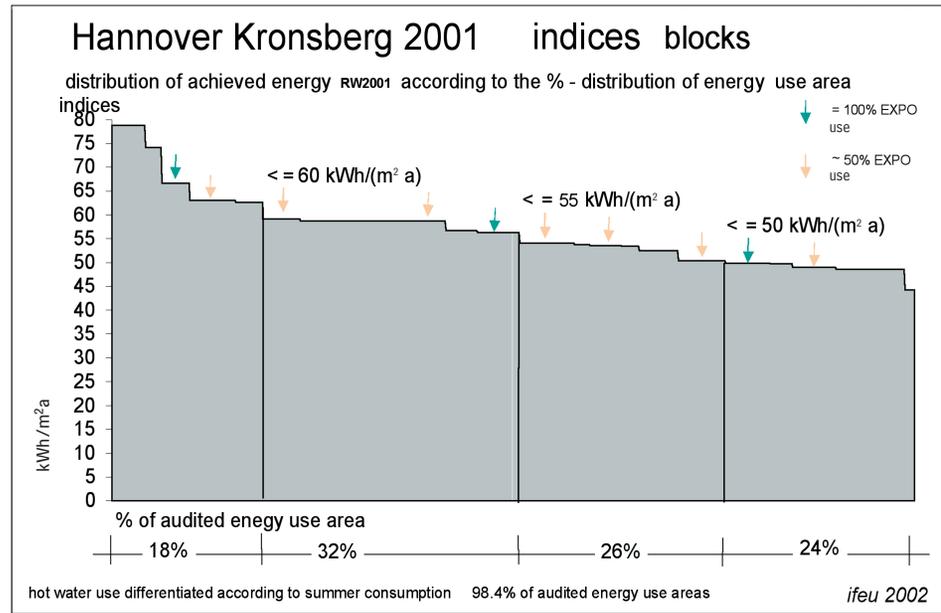
High Standard Building Envelopes

Illustration 1 shows the energy index achieved by each construction block. 24% of the apartments had indices of less than 50 kWh/(m²*a) and another 26% less than 55 kWh/(m²*a). No difference was seen between buildings initially used by EXPO personnel and those with normal tenancies.

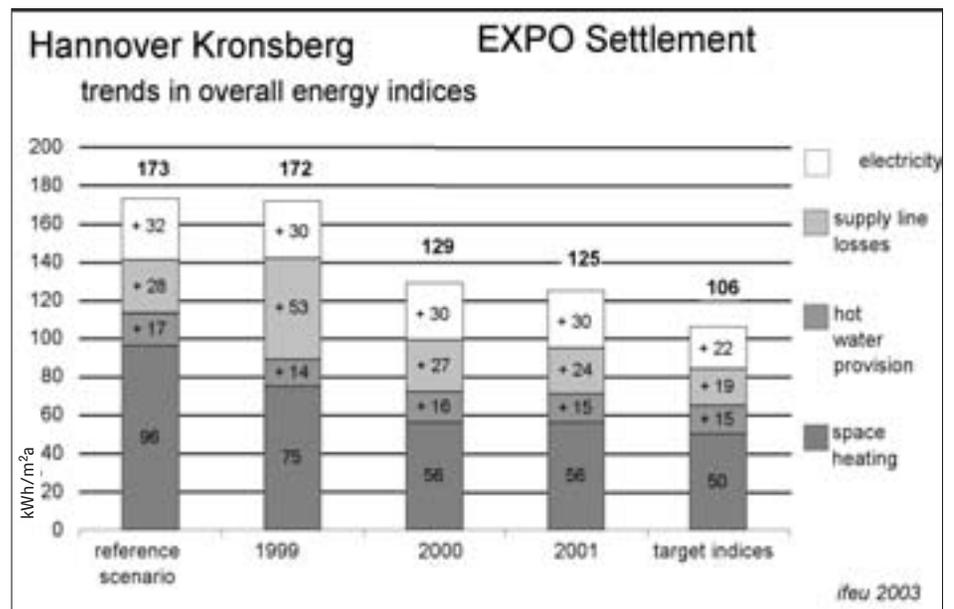
An average energy index for space heating of 56 kWh/(m²*a), very close to the target 'Kronsbergstandard' of 50–55 kWh/(m²*a) was achieved. Compared to construction methods meeting the 1995 national insulation standards (see also illustration 3 – space heating) of around 96 kWh/(m₂*a) this represents a saving of 42%.

The main savings were achieved through excellent insulation of the buildings combined with quality assurance monitoring throughout construction. The cause of high consumption in three separate construction blocks could not be completely ascertained; it apparently lies not with a poorer insulation standard but with inappropriate residents' habits.

Illus. 1 Percentage distribution of energy indices (heating, useable energy) achieved at all development blocks at Hannover Kronsberg in 2001



Illus. 2 Energy consumption indices for heating and electricity at all construction blocks at Hannover Kronsberg, 1999–2001 (from 2001 including former EXPO personnel accommodation)



Hot water consumption as expected

As a base value for the reference scenario, hot water needs of 30 litres per person and day (see illustration 2 – hot water) or 17 kWh/(m²*a) were assumed. The target value lay at 15 kWh/(m²*a). Measurements of hot water demand for 2001 showed a specific useful energy consumption of around 15 kWh/(m²*a). This figure is precisely that of the target scenario.

However, figures on hot water demand were only available for a few construction blocks; the others were estimated from actual summer energy demand. A future collation and publication of hot water demand figures would make the findings more precise.

System losses reduced – still room for improvements in the installation technology

Once all buildings had been connected to the district heating system, in 2001 system losses from the network also decreased to 9%. There emerged (see illustration 3 – supply line losses) an overall specific loss as measured at the calorific meter in the heating centres of 24 kWh/(m²*a), comprising losses from district heating pipework (8.6 kWh/(m²*a)), losses from hot water tanks including pipework (10.8 kWh/(m²*a)) and pipework losses in space heating (4.9 kWh/(m²*a)).

Compared to the reference scenario of separate heating from a gas-fuelled condensation boiler for each block, thermal losses sank by 14% from 28 kWh/(m²*a). The target of 19 kWh/(m²*a) was not achieved; for this, losses from tanks and pipework inside the buildings would have to be almost halved. Here, using specific metering and optimisation of single buildings, the causes for thermal losses should be investigated.

Electricity Saving as a long-term Objective

The reference scenario (see illustration 2 – electricity) assumes electricity consumption of 2.500 kWh per household and year. Related to the average living space, this produces an index of 32 kWh_{el}/(m²*a). Auditing all 2,678 households in the study area, in 2001 there was an average calculated saving of 5.3% (in 1999 and 2000: 6%). The average consumption of a household would thus lay around 2,368 kWh/a, the energy index for electricity at around 30 kWh_{el}/(m²*a).

Only about one-fifth of the intended savings in electricity of 750 kWh/a per household has thus been achieved – still a long way from the target of 30% savings at Hannover Kronsberg, which would produce an index of 22 kWh_{el}/(m²*a) (target index). There remains significant savings potential with white goods, where only a small proportion of households have the most efficient appliances. As, however, only a few new appliances are bought for a move to new accommodation and new tenants are arriving at Kronsberg all the time, the exploitation of this potential will remain a long-term task.

District heating network saves on primary energy

In 2001 both district heating plants were operating as planned. Generating both electricity (8,200 MWh) and heat (20,600 MWh) saves on primary energy, with a dramatic effect on levels of CO₂ emissions. Standard calculations for electricity generation (here: 660g CO₂/kWh) imply specific CO₂ emissions for district heating of just 82g CO₂/kWh approx., far below the reference variant (natural gas, 211g CO₂/kWh).

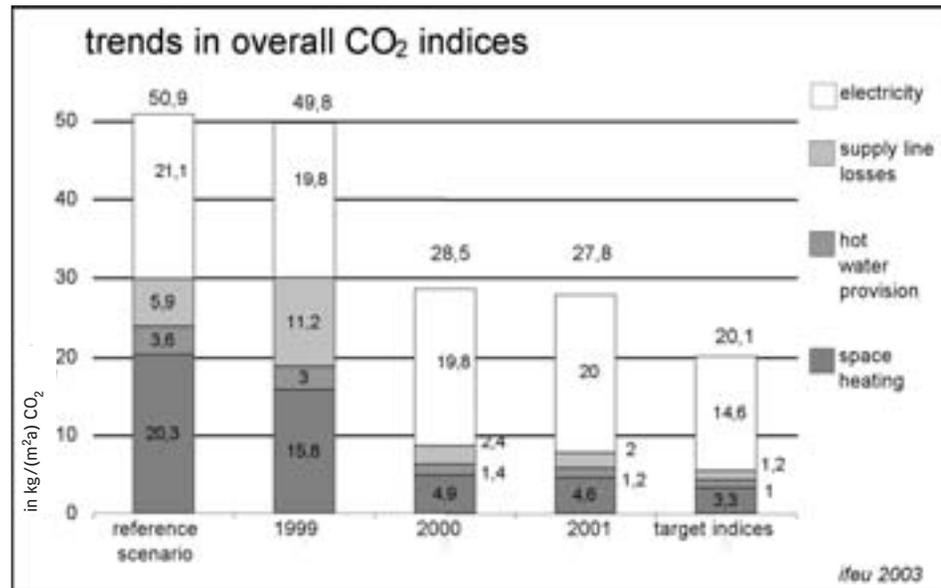
Compared to the reference scenario (see illustration 5) the specific CO₂ emissions through 2001 decreased by 45% from 50.9 to 27.8 kg/(m²*a). This dramatic reduction can be ascribed roughly half and half to end user savings and commissioning of the decentral CHP plants. Related to the audited 2,900 dwellings, CO₂ emissions sank by around 10,800 tonnes to 5,900 tonnes of CO₂ per year or from 3.7 tonnes to around 2 tonnes of CO₂ per dwelling and year.

Wind of change for climate protection

At the end of 2001 three wind turbine generators were in operation on Kronsberg hill: one run by the Herrmannsdorfer Landwirtschaften organic farm (1.8 MW), one by the Hannover energy utility SWH-AG (0.3 MW) and one by the Windwärts association (1.5 MW). This virtually zero-emission electricity generation saved a further 3,100 tonnes of CO₂ in 2001.

If this figure were credited to the households on Kronsberg it would produce a total figure of 2,800 tonnes of CO₂, one tonne per household and a CO₂ reduction of 74% compared to the reference scenario.

Illus.3: Trends in CO₂ indices for all construction blocks at Hannover Kronsberg, 1999 – 2001 (from 2001 also with former EXPO personnel accommodation)



Under the new German energy saving regulations ('Energieeinsparverordnung', EnEV), which have been in force since February 2002, construction standards have been made more stringent compared to the 1995 insulation regulations that were the basis of the Kronsberg reference scenario. At Kronsberg a standard has been implemented that still exceeds the demands of the new EnEV and thus sets an example for future building projects. A model comparison on existing Kronsberg buildings between the

EnEV and Kronsberg calculation methods revealed that the insulation dimensions according to EnEV could be around 25% less. The background to this is that EnEV grants a concession in its calculation when the building is connected to district heating.

Long-term it can be expected that the passive house standard for new buildings will play a stronger role; valuable experience in this field has been gathered at Kronsberg.

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**ENTWICKLUNGSPLANUNG BIS
ZUM JAHR 2000
DEVELOPMENT PLANNING FOR
KRONSBURG THROUGH TO
2000**

- ① Quartierpark/ central neighbourhood park
- ② Spiel & Sportpark/ outdoor sports park
- ③ Spielplatz/ playground
- ④ Stadtteilzentrum/ district square
- ⑤ Grundschule/ primary school
- ⑥ Kindertagesstätte/ children's day centre
- ⑦ Neues Gewerbegebiet/ new commercial estate

