Energy Efficient and Integrated
Urban Development Action

URB Energy

Holistic Strategies for Energy Efficient Refurbishment of the Housing Stock and Renewal of the Related Energy Supply System

WP 4 Transnational Manual

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Foreword and project background

In view of the increasing significance of energy efficiency in the field of urban development, the transnational cooperation project Urb.Energy was launched in January 2009. The aim of the project was to combine measures of energy efficient refurbishment of the housing stock with the overall improvement of residential neighbourhoods. The project was co-funded by the territorial cooperation programme "Baltic Sea Region Programme 2007–2013" as well as by the German federal programme "Transnational Cooperation". 15 partners from Estonia, Germany, Latvia, Lithuania, Poland and Belarus took part in the project and represented key actors in national activities for energy efficient settlement structures.

Cities offer a huge potential for energy saving and the reduction of CO_2 emissions. With their vast housing stock and attached infrastructure they account for around 80 % of the EU's total final energy consumption and 40 % within the building sector. Building envelopes and the energy supply of buildings in particular present a huge saving potential that has to be taken into detailed consideration. To achieve this potential, investment is needed and the behaviour of diverse stakeholders with varying capacities and motivation has to change. The energy efficient renewal of the housing stock requires the consideration of the diverse condition of the buildings and the different urban structures in the Member States, regions and urban areas within the EU.

Need for integrated energy-related modernisation approaches

There is a need for integrated energy-related modernisation approaches on neighbourhood level that take the specific situation into account: the energy balance and the saving potentials of the buildings (with their technical features and quality), the socio-economic situation, the ownership structure and the capacities of owners, the energy supply system and the use of renewable energy (related to a wider regional territory). This is especially necessary when there is scattered ownership, residents with low income and different building types, as there are more obstacles to overcome to develop a suitable renewal concept.

Suitable energy efficient solutions within a complex urban context

Based on the complexity of a large-scale energy efficient urban renewal process, addressing individual buildings and individual actions is just the first step. It is necessary to link various measures, taking the interactions as well as the specific local conditions into account. This requires that the instruments are adapted to the particular region, city or neighbourhood. Integrated energy-related modernisation concepts for urban areas offer a suitable solution to achieve this, when they are adapted to the overall urban context (e.g. energy balance of a neighbourhood, the socio-economic situation, financial capacity of residents etc.).

Key objective of Urb.Energy

Urb.Energy's key objective is the development and implementation of integrated concepts and strategies for the comprehensive energy efficient renewal of residential areas in the Baltic Sea Region. The project is co-ordinated by the German Association for Housing, Urban and Spatial Development as Lead partner and the Housing Initiative for Eastern Europe (IWO).

The partners worked together to combine measures of energy efficient refurbishment of the housing stock with the overall development of residential neighbourhoods and the renewal of the energy supply infrastructure.

One particular focus, as part of the integrated urban development approach, was on methods of energy efficient modernisation of residential buildings and district heating systems. The project partners developed and partly implemented renewal concepts in six target areas. These concepts contained an optimised, comprehensive package of refurbishment measures and new approaches for the neighbourhood heat energy supply including renewable energy sources.

It was crucial that these activities were implemented with the agreement of local stakeholders such as residents, homeowner associations, energy providers, city council, etc. Thus, in the development of related concepts and measures these stakeholders were involved and motivated to take part in the process.

"Old" EU Member States such as Germany contributed their experience in the energy efficient regeneration of large housing estates and the development of integrated energy efficiency strategies and concepts for urban neighbourhoods and cities. In general the partners tried to include energy and climate issues within the urban development policies and instruments. The developed and applied approaches provided valuable transferable know-how and experience as well as methods, tools and procedures.

Urb.Energy main outputs

In addition to this manual on **holistic strategies for energy efficient refurbishment of the housing stock and renewal of the related energy supply system,** the results and findings of the 3-year Urb.Energy project are summarised in three further documents:

- **Manual on an integrated urban development approach targeting at energy efficient residential areas**

  The manual explains the need for integrated urban development approaches with a focus on energy relevant issues in order to target the improvement of energy efficiency of residential neighborhoods with their modernisation. It gives practical operational advice to local administrations on how to plan and implement such approaches successfully.
- **Guidelines for innovative use of EU Funds for Measures in the Housing Sector and deprived urban Areas**

  The guidelines present a more practical approach to available funding options on both national and EU level. They can be used by local, regional or national actors when drawing up financing schemes for EER or integrated urban development concepts.
- **Policy recommendations: Energy efficient urban areas and neighbourhoods – A contribution to liveable and competitive cities**

  This paper presents five main recommendations, based on the experience of the Urb.Energy partners, to put municipalities in a good position to increase the energy efficiency of cities and their neighbourhoods and to develop an affordable and climate-friendly energy supply in combination with the modernisation of city districts.

1 Introduction to the manual

In order to be transferable to other urban areas in the EU and municipalities, this manual presents an overview of various suitable and realistic approaches to implement energy and climate friendly measures to improve energy efficiency and the use of renewable energy sources in the building sector, embedded in the framework of an integrated energy efficiency concept for urban neighbourhoods, especially for residential areas.

Since the project findings have shown that different residential urban areas and administrative and socio-economic conditions need different actions related to the enhancement of energy efficiency, i.e. tailored to the age and status of the buildings, the owner structure and the energy supply structure, this manual goes beyond the presentation of just one holistic strategy or a fixed set of recommendations on how to implement energy efficient refurbishment and renewal of energy supply systems.

In *Chapter 2* general and specific recommendations on different aspects of a holistic strategy for neighbourhood energy efficiency concepts are presented. The recommendations are derived from the experience gained by the project partners. These recommendations cover a set of more general recommendations on administrative structures, capacity building and promotional activities and on how to embed such concepts in a larger framework like a municipal energy strategy and climate protection concept. Also quite specific technical and methodological recommendations are given that are suitable for specific technical situations. These cover issues like the "right" mix of energy sources for neighbourhoods with homogenous and heterogeneous building structures. At the end of the chapter, recommendations are presented for the first actions that a municipality can take to increase energy efficiency.

In *Chapter 3* good practice approaches that were developed under different framework conditions, are presented. These examples highlight the lessons learnt and conclusions drawn during the planning process in the target areas of the project partners as well as the implementation process of energy efficiency concepts in German cities. These examples transfer innovative approaches and learning between the municipalities in the Baltic Sea Region and throughout Europe.

The examples illustrate different solutions which are available and successfully planned and/or implemented, methods of the technical adaptation of energy systems, the increased use of renewable energy sources in district heating and an intensified use of combined heat and power plants. Concepts for improved user behaviour and better technical maintenance supported by awareness raising campaigns, training courses and communication measures are also topics highlighted in this document.

Building on the first attempts to plan and test small scale measures in a neighbourhood and the development of feasible practical solutions, the manual provides lessons learnt and recommendations with the aim to present advice to practitioners on local level to choose appropriate solutions and find the right energy efficiency measures and concepts for their cities and neighbourhoods.

2 Recommendations

The development and implementation of municipal and neighbourhood energy and climate concepts are intended to support the reduction of energy consumption and CO_2 emissions. Such concepts help to set energy and climate goals and to prepare the (technical) foundation for energy efficiency measures, measures to reduce energy consumption and to strengthen the use of renewable energy at city and neighbourhood level. In this document such measures are summarised with the term "energy efficiency". It is recommended to have an energy and climate concept as part of an integrated urban development concept (IUDC), but it can also be a supplementing sectoral concept.

The main components of energy and climate concepts are:

- The energy balance, analysing the energy supply and consumption of the city or neighbourhood and its CO_2 emissions,
- The evaluation of the potential to save energy in the city or neighbourhood based on the results of the energy balance,
- Energy and climate objectives, which could include targets for the reduction of energy consumption and CO_2 emissions, the rate of energy-saving renovation of buildings, the integration of renewable energy sources in the energy supply,
- An action plan with priority and feasible measures to reach the objectives e.g. through energy efficiency measures, the use of renewable energy, optimising the energy supply infrastructure, developing the municipality's role in setting a good example,
- A plan for managing and monitoring the implementation of measures to increase energy efficiency and climate protection.

In this chapter recommendations are given on how to implement holistic strategies via energy efficiency concepts. The recommendations range from the long term perspective to contribute to climate protection and energy efficiency of a city and/or region with ambitious political and administrative goals towards more operational recommendations on how to initiate an energy efficiency concept for a single area. The recommendations are predominantly derived from the good practice examples (cf. Chapter 3) and the intense discussions in the Urb.Energy project. They are partly based on additional thematic expertise especially compiled by the project partners in Brandenburg and Berlin.

The specific urban context and the socioeconomic and energy situation require a holistic approach tailor-made to the given situation. Therefore the following recommendations can be used as a flexible guide. Though it is advisable to start with an energy efficiency concept embedded in an integrated urban development concept (IUDC) for the entire city area, substantiated and made operational by a neighbourhood energy efficiency concept, it also can be reasonable to start with small scale energy efficiency (pilot) projects or an energy efficiency concept for a smaller area to test and learn from the experience before developing the energy concept for the entire city area. The strategies in the good practice examples (cf. Chapter 3) cover both approaches and both were successful for their specific situation. The framework conditions and the available resources and budget have to be taken into consideration to decide which approach is more suitable in a city.

Technical measures can also differ from "stand alone" solutions for an individual building towards energy efficiency refurbishment concepts for a whole residential area. Soft approaches like influencing user behaviour through motivation and awareness campaigns and low budget approaches like improved technical maintenance and training of technical staff can contribute to the EU 20-20-20 strategy's objectives, as can more sophisticated technical solutions and/or large scale measures like the construction of new small scale district power plants that use renewable sources. Which approach is more suitable depends on the available resources and budget.

2.1 Recommendations for the development of energy efficiency concepts and measures and supporting structures

The Urb.Energy project has demonstrated the importance of energy efficiency concepts for the improvement of the energy efficiency in residential neighbourhoods. To increase the impact of such concepts, an excellent method was to embed the measures of the energy efficiency concept in the municipal/neighbourhood IUDC. The impact was even greater when energy and climate issues were considered in urban planning principles, programmes and action plans for the respective area. Solitary energy efficiency concepts not linked to an IUDC or IUDCs that did not address energy and climate issues had a much weaker impact on climate adaptation and energy reduction/efficiency in a city and its neighbourhoods. It is also of importance to embed energy efficiency into energy action plans or comparable energy strategies on regional level.

There is additionally a need to embed energy policy in the urban development framework on a long-term basis, to establish an effective monitoring system and to create internal administrative structures to optimise municipal work on energy issues.

Individual large homogeneous housing developments can be turned into "model energy-efficient districts" and provide good examples of consolidation. A set of criteria should make it easier to decide whether to opt for a centralised or decentralised heating network when drafting district concepts for energy efficiency, especially in districts with old buildings.

2.1.1 Involve local stakeholders and raise their awareness

The cooperation and participation of stakeholders, e.g. residents, local housing and apartment owner associations, the local administration and local council, play a vital role in the development and implementation of energy and climate concepts. The good practice examples from the project partners have demonstrated very clearly that a set of measures is needed to improve participation and thus motivate owners to invest in energy efficiency.

The involvement of local key stakeholders should be targeted at the development and coordination of objectives and actions in the concept that are supported by the stakeholders and correspond to their needs. Adequate, group-orientated participation measures have to be applied to recognise their interests and create a climate of confidence and cooperation.

Therefore it is recommended to

- Establish a multidisciplinary working group with public and private key stakeholders, which focuses in particular on developing an energy efficiency concept and supervises implementation;
- Set up an independent specialist advisory council at municipal level that includes interested parties and stakeholders, and forms a local network;
- Participate in external city networks at regional, state and national level to exchange experience and raise awareness, if appropriate.

Further awareness raising campaigns, information meetings and if possible continuous support by experts in the area proved to be very useful. Also discussion rounds with the owner associations and their facility managers are recommended to motivate them. This is needed for the correct handling of technical maintenance as well as for the steering of discussions about investment decisions. The information campaign should focus on benefits and economically feasible energy efficiency measures, use of renewable energy and low energy construction technology. Information about financing opportunities is also important.

Competitions are also an appropriate way to increase awareness and motivate local stakeholders. This includes participation in national or regional competitions, e.g. between municipalities on energy efficiency or conservation projects, and also in competitions within the municipality (e.g. between schools on investment projects). Both of these would have an internal and external impact and contribute to building a good public image.

Strategies to switch the supply from traditional to more sustainable energy sources and improved power plant technology require cooperation with the local and/or regional suppliers, whereas strategies to change the behaviour of end users require cooperation and exchange of information with owners and residents.

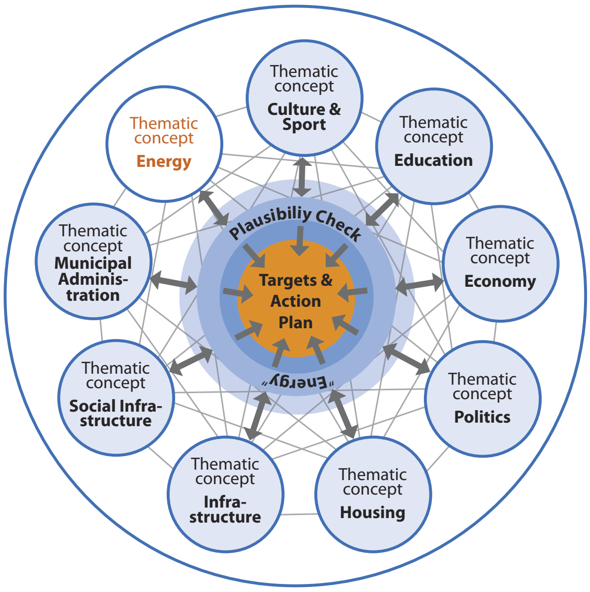

Diagram 1: Interplay of the plausibility check (Source: based on BTU Cottbus)

2.1.2 Analyse the energy supply, energy consumption and the energy efficiency potentials

Energy and climate concepts need a solid analytic base. Appropriate tools for the analysis should provide methodological support, such as Riga's classification of building types according to construction period and energy consumption, or for example, a local map showing the distribution of heat or CO_2 emissions as some German cities have developed. In addition, details about energy efficiency potential should be provided.

It is recommended that buildings are grouped according to age and energy characteristics, enabling general conclusions to be drawn about energy requirements and renovation solutions. In neighbourhoods with heterogeneous building types, municipalities should also examine the possibility of creating "energy clusters", which emphasise similarities in relation to utility provision, socio-spatial organisation and urban development within connected neighbourhood structures. By creating energy clusters, it is possible to develop specific recommendations for action without having to examine each building individually, which can be cost intensive.

The analysis should also examine the existing energy supply system related to the construction structure of the specific area. Furthermore, an estimate of the energy requirement of neighbourhoods or supply areas should be carried out as part of the inventory of the housing stock with the help of an energy plausibility check.

The **plausibility check** is a process for verifying current and potential future energy supply systems for their energy-related plausibility. It shows the influence of settlement structure type, building density, settlement area size, building typology and building upgrade status on the energy balance of a neighbourhood or supply area. The process is divided into two stages: a general and a detailed check.

The general check provides an overview of suitable energy supply systems in different settlement structures with different building types and upgrade statuses. It indicates the typical energy requirements of buildings in characteristic settlement structures and acts as a basis for the comparison of estimates for the energy consumption of settlement areas in individual neighbourhoods. The general check also indicates which energy supply system is worthwhile for which level of energy requirement in a particular settlement type with the associated building types at different levels of upgrading.

The detailed check provides a basis for the specific energy-related analysis of a neighbourhood or supply area. It is a tool to estimate the energy requirement of neighbourhoods/supply areas before and after appropriate refurbishment measures in the building stock have been carried out. In addition, the energy efficiency of the supply systems can also be verified using the detailed check. Interactions that arise either in the modification or retention of the existing supply system are taken into account in the overall calculation.

The basis of the plausibility check is the definition of "energy-relevant settlement types of local settlement structures" and a "German building typology". The system underlying the energy plausibility check can be applied to other federal states and situations, however the settlement and building typologies must be adapted to the relevant structures and climatic conditions.

The plausibility check process and the interactions with urban design and energetic urban renewal are depicted below.

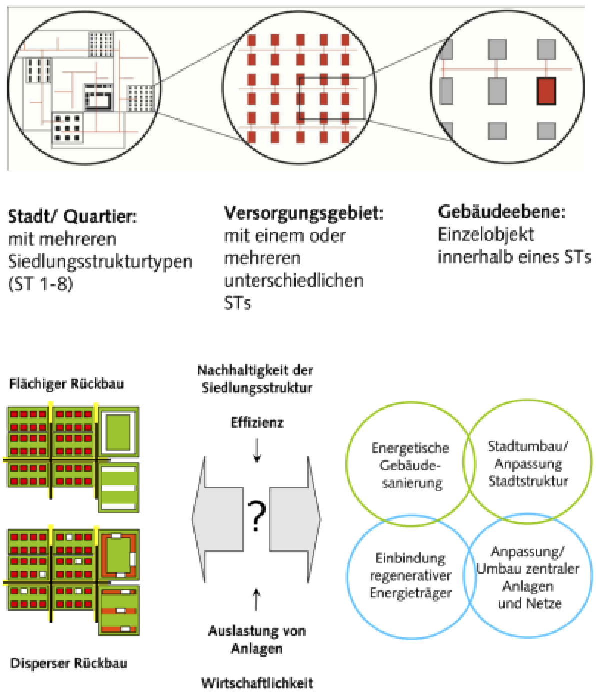

Diagram 2: Steps of implementation (Source: BTU Cottbus)

As part of preparing the energy upgrading of buildings, it has been standard practice in Germany to roughly estimate energy consumption and reasonable energy construction measures, and then develop specific energy efficiency refurbishment plans on the basis of this detailed but pragmatic analysis (e.g. energy performance certificates, rough energy analyses). This approach that ensures that energy aspects are given suitable consideration in urban planning processes has proven successful.

The German partners in Berlin and Brandenburg both developed methodological tools to measure and monitor the energy potential/demand of certain types of buildings: Berlin developed a monitoring tool, see the description in Chapter 3 as one of the good practice examples; and Brandenburg just recently finalised a research project on the "plausibility check" explained above, developed by the Technical University of Cottbus.

A proven methodological approach to facilitate such estimations is the classification of building types according to their energy needs. This classification was developed for various types of prefabricated buildings, age and typical material used for certain construction periods.

The plausibility check enables the verification of the energy efficiency of the supply systems. In addition, crucial factors for the energy balance of a neighbourhood or supply area are identified (settlement structure type, building density, settlement area size, building typology and building upgrade status). The plausibility check was developed as an instrument in the context of the research field "Energy efficient urban renewal" funded by the German Federal Ministry for Urban Development, Construction and Transport.

2.1.3 Make climate protection agreements with housing owner associations

Energy and climate protection agreements with housing owner and comparable associations play an important role in municipal energy and climate protection policies. Similar agreements in the past have shown how efficient a joint, coordinated approach can be. The energy and climate protection agreements help to raise awareness and provide good publicity for any success that has been achieved and also for any new measures or courses of action. Owner associations may need continuous support for some time. The visualisation of goals like smart metering or bill boards that show the energy saved/used can usually help to get individual owners motivated to participate in such agreements.

2.1.4
Implement low-cost measures to reduce the energy consumption

Given the declining population figures in many European cities and the limited scope to provide financing, local stakeholders have started to focus more on low-cost measures to increase the energy efficiency of their buildings. Low-cost measures have a considerable potential of an estimated 10–15 % to increase the energy efficiency of buildings through changing user behaviour, better technical maintenance and small low cost investment measures. Often this can be achieved with smaller investments without having to carry out structural changes. These measures include for example adjusting system settings (e.g. hydraulic balancing), improving control systems (efficient pumps, changing thermostatic valves) and laying the technical foundations for energy-optimised management (optimising the connected load, intelligent control cabinet technology, etc.).

Neighbourhoods with similar building types, for example large housing areas of similar prefabrication type, usually have a high potential to make energy savings by implementing low-cost measures such as adjusting the heating characteristics of the house connection substations or carrying out hydraulic balancing. A study carried out in Cottbus-Ströbitz in Brandenburg calculated that the potential energy savings that could be made by altering the heating curve in the buildings would be between € 0.15/m^2 and € 0.18/m^2. The energy saving potential of optimal heating curves presents an expected energy saving of 5–35 % in relation with common heating curves, though the full benefits of this method will only come to account if the system is properly balanced in terms of hydraulics and air.

Compared to large-scale energy efficient renovation, the cost-benefit ratio of low-cost measures is significantly higher. For around one hundredth of the cost, it is possible to make savings that correspond to roughly a tenth of the savings potential of more comprehensive measures. However, extensive technical expertise is needed to implement low-cost measures in order to ensure that suitable efficiency measures are competently identified for each individual case and that expert support is provided during the implementation process.

2.1.5
Appoint a municipal climate and energy manager

The increasing significance of energy efficiency and climate change and the importance attached to it in municipal policies means that municipalities must have robust internal and administrative systems.

It is recommended that municipal energy managers are appointed to support towns and cities in developing a) energy concepts, b) quality management, monitoring and control systems and c) energy portfolio management. For smaller towns where appointing an energy manager may be too expensive, there is a possibility of assigning one manager to cover several municipalities, for example within the framework of a partnership arrangement, a municipal consortium or a special network of cities for climate protection/energy.

Energy/climate protection managers play a key role in supporting this new area of action (climate and energy) in local administrations by clearly setting out the responsibilities and scope of action. Any additional capacities are determined by the size of the town or city. It is highly recommended that this role is established within the municipality's core administrative structure, either as a separate department or within a department that takes a cross-sectoral approach (e.g. urban development). It is crucial that an adequate job profile is created to maintain expertise and also to develop and publicise the topic within the administration and the town or city. Alternatively, or rather in addition, appropriate expertise could also be drawn from local energy agencies or public utility companies.

In many cases, external experts are also needed. On the one hand, this means making use of objective know-how for integrated processes and communication; on the other, it means using specialised knowledge for problem-orientated research (e.g. energy-efficient renovation of buildings and heating networks).

2.1.6
Provide training to structural engineering/building service companies

Building contractors often lack the necessary expertise to set up building services that enable the buildings to function optimally or to install components and building materials that makes it possible to actually achieve the estimated energy reduction figures. Given the rapid increase in energy requirements, new training modules for structural engineering and building service companies are needed that document for example common deficiencies, highlight their impact on energy needs and state of the art solutions.

2.1.7
Develop differentiated methods for neighbourhoods with heterogeneous and homogenous building structures

Tailor made strategies for neighbourhoods with heterogeneous and homogenous building structures for the generation, supply and utilisation of energy have contributed to solutions that are economically viable. If concepts are differentiated according to the different building structures then it is easier to implement strategies that involve different forms of energy sources and supply. This approach also makes it possible to incorporate solutions for any new requirements and to use new technical innovations.

There is also the potential to increase energy efficiency in existing power plant networks by implementing new technology and using renewable sources of energy as extensively as possible (wind power, hydropower, geothermal energy and bioenergy). Since the opportunity afforded by new technology often comes along unexpectedly, its implementation depends on the flexibility of local and regional energy concepts. An international exchange on energy-efficient innovation (which should also discuss smart grids) is urgently needed in order to give project partners the best opportunity to increase efficiency. The expansion of renewable energy sources can also be strengthened and initiated by support from investors such as community funds and public parks or bioenergy villages.

For homogenous residential areas it is recommended to:

- Optimise the district heating networks: in order to optimise the district heating networks in large housing developments, it is advised to assess the potential of the following options within each district's energy efficiency concept:
  - Evaluate the efficiency of the heat supply network. This involves considering ways to compensate for anticipated underuse of the existing heat supply networks. Some of the options for counteracting this inefficiency include expanding the network or connecting areas with heterogeneous structures to the system. If the existing supply system is no longer cost-efficient, a standalone system should also be considered.
  - Use renewable sources of energy. Any public utility companies and energy providers that have already exploited the full potential of cogeneration within their district heating networks should consider switching from using fossil fuels to integrating decentralised solutions (e.g. solar thermal energy, biomass cogeneration plants, etc.) into the existing network. A solar atlas should be produced that illustrates the potential of using roof areas in homogeneous districts for solar power generation systems.

In heterogeneous residential areas (areas with old brick or wooden buildings, different construction periods), the structure of ownership and the energy profiles of the buildings are very diverse. The following actions are recommended:

- Establish a set of criteria for centralised or decentralised heating networks which can form the basis for a district energy efficiency concept. The starting point for energy efficiency concepts developed by municipalities for heterogeneous districts should be a set of criteria that allows individual municipalities to decide whether to opt for a centralised or a decentralised heating network.
- Decentralised systems are an advantage if heat requirements are expected to sink in the future (as a result of energy-efficient renovation and falling population figures), if there are large distribution distances between energy clusters, and/or if it is not possible to further expand the central network for technical or economic reasons.
- Centralised networks, on the other hand, are the preferred choice if they are efficient in the long

term and the network structure can be expanded without having to make any major changes, if heat provision is energy efficient and economically competitive (e.g. the network uses waste heat from power plants), and/or if energy can be supplied at competitive rates.

- If it is not possible to implement energy efficiency measures in listed/architecturally significant buildings, compensation measures can be used instead. These include switching to using renewable sources of energy (e.g. solar thermal energy, photovoltaic, geothermal energy, etc.) or energy-efficient solutions (e.g. industrial waste heat, co-generation plant clusters, etc.) as individual or communal local heating solutions.
- Particularly in heterogeneous areas, it is only at district level that it is possible to identify where there is potential and therefore to reveal the broad spectrum of opportunities for energy-efficient urban development. By forming and classifying related urban clusters, it is possible to develop specific recommendations without having to examine each house individually that can be costly. The district and municipal concepts can then be mutually adapted.

2.2 Recommendations for first energy efficiency measures and securing quality and support of energy efficient refurbishment works

Many municipalities in the Baltic Sea Region and the Eastern Partnership countries will be implementing energy efficiency measures for prefabricated housing for the first time. The valuable lessons learnt by the project partners in the target areas, in particularly in Piaseczo and Riga, led to the following recommendations on basic energy efficiency measures for individual buildings that can be implemented as a first step towards energy efficiency. The measures also assist in ensuring the quality and support of the energy efficient refurbishment and concept.

2.2.1 Energy efficiency measures on building level

- Analyse the existing rehabilitation and energy situation and find the reasons why the activity of apartment owners to refurbish residential buildings is still low.
- Calculate the energy, economic, and ecological results of the optimal variant of thermomodernisation investments, which depend on the evaluation of the existing condition of external walls, central heating and domestic hot water systems.
- Replace individual heat generators and modernise central heating systems according to the results from the energy assessment; at least thermostatic valves should be installed on radiators and on vertical pipes. Use district heating, combined heat and power if possible and feasible.
- Improve the thermal insulation of buildings (recommendation for Urb.Energy target areas: thermal insulation thickness of external partitions of at least 12 cm in order to achieve required R = 4.0 m²K/W for walls, R = 4.5 m²K/W for walls and roof).
- Insulate the floor of the cellar instead of the cellar ceiling, as well as insulate the roof of the building instead of the attic floor.
- Replace old windows and doors with a lower value of the heat transfer coefficient (U = 1.3 W/m²K for windows and 2 W/m²K for doors).
- Replace individual boilers for hot water preparation by central domestic hot water installation or solar domestic hot water with a bivalent cistern and decentralized exhaust-air plant with heat recovery and air density validation.

2.2.2 Actions to secure the quality and the support of the energy efficient refurbishment works

- The refurbishment of buildings and apartments should be carried out by professionals rather than by the apartment owners to ensure the professional implementation of the work.
- Only companies with an established quality management system should be chosen for the man-

agement of the renovation and implementation of the construction works.

- An agreement should be included in the contract between apartment owners and the company that will carry out the refurbishment work, requiring that the energy savings stated in the energy audit will be reached as a result of the refurbishment.
- For the refurbishment of multi-apartment buildings, a common order form should be used, in which the technical designs of all refurbishment measures are listed.
- Support structures for the energy efficient refurbishment have to be established, i.e. an ombudsman for energy efficient refurbishment or a public agency offering information and support to the inhabitants and property owners.
- The legislation should be prepared to regulate the responsibility of energy auditors, construction supervisors etc. via liability insurance so that the quality of construction and refurbishment work can be ensured.

2.2.3 Neighbourhood refurbishment concept

- A refurbishment concept has to be developed that explains how to effectively organise the refurbishment process and to access the needed financial resources.
- The refurbishment concept has to be developed with the key stakeholders and carefully explained to the inhabitants and apartment owners to gain their support. The awareness about the necessity and benefits of such measures is still low and has to be increased. Awareness campaigns have proven to be most effective.
- The neighbourhood refurbishment project needs political support for its successful implementation.

3 Good practice examples

In this chapter good practice examples are presented. They consist of contributions from the Urb.Energy target areas developed as part of the project (p. 20–55). They are supplemented by case studies from project partners in Berlin and Brandenburg, Germany that highlight planning approaches towards energy efficiency measures, in particular showing concepts of today and during the last 20 years (p. 56–60). Additional examples from German municipalities round off the good practice examples of holistic strategies (p. 64–93) in order to cover further types of residential areas with specific supply and building structures and to demonstrate innovative projects using state of the art technology and energy efficiency refurbishment concepts. Last but not least, the energy efficient refurbishment of a prefabricated residential building in Riga that was financed and planned by the Berlin administration in 1999 is presented (p. 61–63).

The holistic strategies presented in the good practice examples cover a broad range of energy concepts and measures for various urban areas. The described energy efficiency measures and concepts range from small areas i.e. a couple of residential buildings of a similar type, to quite large urban areas such as a neighbourhood with ten thousand inhabitants. The methodological approach also varies, e.g. improving the supply/the network technology towards approaches for a single building or even an individual apartment and changing the behaviour of residents.

To facilitate the reader's orientation, the following diagram gives information on the specific focuses of each project, thus enabling an effective and easily accessible structure of the information. The examples relate to the entire project duration; many projects are in still implementation or even in the initial stages of execution.

The examples have been sorted into various groups of measures, and assigned a colour coded symbol to enable the reader to see the focus of the examples easily. They are shown according to the following scheme:

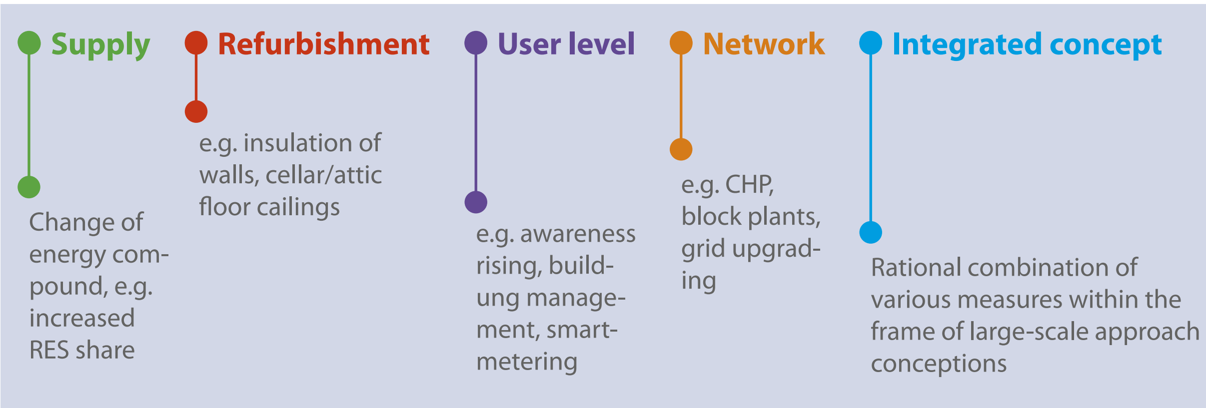

Diagram 3: Colour scheme to illustrate measure group categories (Source: B.&S.U.mbH)

The good practice examples planned and partially implemented by Urb.Energy partners are presented and demonstrate under which conditions energy efficiency measures can be realized successfully, how detected barriers can be overcome and solutions developed that fit the local, regional and national conditions.

The following overview shows the focus of the examples, enabling the reader to navigate and find the priority measures of their choice.

Project name	Types of measures				
	Supply	Refurbish-ment	User level	Network	Integrated concept
Creation of the "Concept of energy efficiency increase of multi-storey buildings in Jelgava", Latvia (p. 20)		●			
Development of a "Concept for Energy Efficient Renovation of the Building Stock of Jugla" in Riga, Latvia (p. 24)		●		●	
Model Energy Efficient Refurbishment of three Soviet-Era Buildings in Lida, Belarus (p. 30)		●			
Development of a Concept of Energy Efficient Refurbishment of Residential Buildings located in the Area A1MWU, Piaseczno, Poland (p. 33)		●		●	
An analysis of the energy consumption and efficiency of apartment buildings on Seminari Street in Rakvere, Estonia (p. 39)		●			
Development of the "Energy Chapter" of the Integrated Urban Development Concept for two areas in Šiauliai, Lithuania (p. 45)		●	●		
Solar-thermal facilities combined with district heating and enhanced cladding in Potsdam (p. 49)	●	●		●	
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New tool to analyse the energy potential of prefabricated buildings – retrospective case study Berlin (p. 56)	●	●		●	
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Wohnungsbaugenossenschaft „Bremer Höhe" (p. 64)	●	●		●	
Concerto-Projekt Hannover (p. 65)	●	●	●	●	
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Innovation City Bottrop (p. 75)	●	●		●	●
Energy efficient renovation of the Märkischen Viertel (p. 77)	●	●	●	●	●
Energy efficient refurbishment of the Prae-Bau Siedlung in Dortmund-Mengede (p. 79)		●		●	
Energy-efficient renovation of the Weegerhof housing estate of the Spar- und Bauverein Solingen eG – district heating from cogeneration (p. 81)			●	●	
Solar Community Köln-Riehl (p. 83)	●	●		●	
Heidelberg „Wohnquartier Blaue Heimat" (p. 85)	●	●	●	●	●
Integrated District Energy Concept Karlsruhe-Rintheim (p. 87)			●	●	●
Renovation, renewable energy and electric mobility in Dresden/Gorbitz (p. 90)		●	●	●	●
Upgrading of district heating by low-scale investments in Wernigerode (p. 92)				●	

Diagram 4: Projects and related measures (Source: B.&S.U.mbH)

Urb.Energy good practice examples

3.1
Project: Creation of the "Concept of energy efficiency increase of multi-storey buildings in Jelgava"

● Supply ● **Refurbishment** ● User level ● Network ● Integrated concept

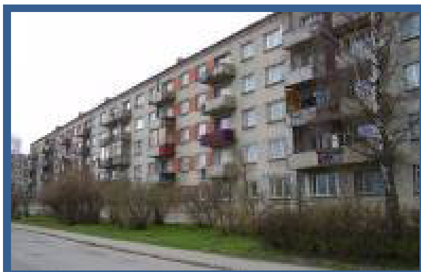

Image 1: Typical buildings in Jelgava TA
© Jelgava city municipality

Location:	**Jelgava, Latvia**
Period of construction:	**1948–1989**
Settlement character:	**220 apartment buildings, public buildings and shops**
Project status:	
Implemented by:	**Jelgava City Council**
Programme:	**Urb.Energy**

General information
Jelgava is a city in central Latvia about 41 km southwest of Riga. With 64,279 inhabitants, it is the fourth largest city in Latvia. The target area is situated in the city centre of Jelgava and is a mixed residential and business area. It consists of shops and public buildings as well as a number of multi-storey residential houses. After the majority of the city was destroyed in World War II, reconstruction started in the late 1940-60ies using standard Soviet designs. 75 % of multi-apartment buildings in Latvia are built using serial designs such as these. The target area has around 20,630 inhabitants, accounting for about a third of the total population of Jelgava.

Initial Energy Performance
A large part of the target area is connected to a district heating system that has been replaced since the Soviet period. Two co-generation power stations provide heat to the area and also produce electricity which is fed into the grid. The power stations were refurbished and meet modern standards using natural gas with the future option to use biomass for energy generation.
The buildings in the area are in a relatively good condition structurally. The residents have already taken some steps to increase energy efficiency such as installing modern windows. Insulation and the internal utilities in the buildings are lacking or in a poor condition.
Although the Republic of Latvia had adopted several pieces of legislation since the EC Directive on the Energy Performance of Buildings was accepted in 2002, and although EU funds are available to support the energy efficient renovation of multi-apartment buildings, the implementation of such projects is still not common place. Results of previous energy efficient renovation projects of multi-apartment buildings have shown that it is possible, through activities such as installing efficient insulation to the building shell, to reduce heating energy consumption by 40–60 %.

Aim of the Project
The main aim of the project is to develop a concept for the upgrading and energy efficient renovation of the multi-storey residential buildings within the target area. This concept will then form part of an integrated urban development concept, which will provide for a comprehensive approach for the enhancement of the neighbourhood.
The idea behind the development of the concept is to change the traditional way of carrying out the renovation of multi-apartment buildings. While it was previously left to the residents themselves to renovate,

organise and to raise funds for the renovation, it was the project's intention to develop a new professional service, or "renovation product" to lighten the burden on the residents and thus enable more renovations to be carried out. The new service would consist of the professional preparation of the construction process documentation for particular multi-apartment buildings, including an energy audit report, a technical inspection, a technical design, an estimate of construction works, renovation payment volume and schedule, a draft contract of renovation realization including defining the obligation of all parties involved. In addition, the aim is to explain to the apartment owners how the structure of the renovation process works and the potential benefits from the renovation process. This would enable the apartment owners to make informed decisions on whether to renovate the buildings with the assistance of the "renovation product".

Image 2: Icicles show insufficient roof insulation in apartment buildings © Jelgava city municipality

Activities

The approach for preparation of "Concept of energy efficiency increase of multi-storey buildings in Jelgava" consisted of the following activities:

1. Detailed analysis of the current situation to identify the characteristics of the main operational and constructional defects of the standard types of buildings in Jelgava city centre.
2. Analysis of the heating energy consumption for various building types for the period between 2006 and 2009. Buildings in each construction series were grouped according to their heating energy consumption per square meter of heating space of the building.
3. The construction works of energy efficient reconstruction of building types for two renovation programmes were listed, including or excluding air circulation systems in apartments and heating energy recovery using recuperation.
4. A comparison of cost of heating energy and costs of renovation was carried out. The construction costs were calculated according to renovation programmes.
5. An overview of funding for the renovation process was compiled, as well as providing an analysis of the decision-making process of the apartment owners in line with existing legislation of the Republic of Latvia.
6. Gathering existing experience and problems regarding complex energy efficient renovation of multi-apartment buildings. An analysis was made using monitoring reports of renovated buildings, which were completed before 2008.
7. A study of the need to improve the microclimate of the premises was conducted. It must be pointed out that none of the finished renovation projects includes improved air circulation and microclimate of the buildings.
8. Recommendations for practical renovation realisation in Jelgava city were developed. As a result of the building renovations in Jelgava, significant savings in heating energy should be achieved. In addition, an attractive architectural image of the buildings of city centre should be created, new jobs provided and renovation construction skills developed.

To promote the idea of energy efficiency, the municipality also provided training sessions and informative seminars for building managers, meetings for apartment owner's organized by building managers and published brochures and leaflets to provide information to flat owners and the general public.

Results

The main result of the project is the "Concept of energy efficiency increase of multi-storey buildings in Jelgava". This contains the results of the analyses listed in the section above.

Image 3: Outdated heating, water and sewage pipelines
© Jelgava city municipality

The building types analysed included the 103rd and 104th series five-storey apartment buildings and the 316th and 318th series five-storey apartment buildings. Typical defects that were identified include outdated hot water supply systems, old inefficient windows and doors, gaps between slabs and cracks in the walls due to poor construction and insufficient roof insulation. Recommendations were formulated to repair these defects in all of the building series as well as to improve their energy performance.
Two programmes were created for the energy efficient renovation of the building series.
Programme 1 includes insulation of the building shell, window replacement according to LBN 002-01 requirements, heating renovation work to the thermostat and to use measuring devices. In the programme it is not intended to install ventilation systems. Depending on the current state of the building and the quality of the renovation work, heat energy savings can range from 7 % to 63 %, compared to consumption prior to refurbishment (please see Table 1).

Programme 2 includes building shell insulation work in accordance with European Union Directives relating to low energy building design and standards that will apply in most European countries by 2020. This programme provides for building walls and other structures with Neoporu insulation (guide thickness b = 25 cm), replacement of windows with the heat transfer coefficient of 0.8 to 1.1 W/m^{2}K; heating system renovation similar to Programme 1, the ventilation system in accordance with Latvian and EU laws and regulations. In the case of implementation of this programme, thermal heating savings are 40% to 79%, compared to consumption prior to renovation.
Model calculations were then carried out for the renovation of each of the four building series types and for the two Renovation Programmes to calculate the thermal energy savings and payment balances. It was found that Programme 2 would save two times more heat energy, it would cost around 1.5 times more than Programme 1.

Lessons learnt

In Latvia the absolute “must haves” to start a large-scale renovation project are political support (on the municipal and state level) and effective, high quality organisation, keeping in mind that the building renovation must be carried out by professionals not apartment owners, i.e. apartment owners should contract the renovation service from a professional municipal or private company.
When a concept for the renovation of multi-apartment buildings in a neighbourhood, city or state is prepared, it can be advised not to focus too much on the details of the existing condition of the buildings (level of deterioration of façade and pipes, percentage of new and old windows, etc.) or too detailed

Type of building	Average specific heat consumption, kWh/m² per year	Heat-saving potential, Renovation Programme 1	Heat-saving potential, Renovation Programme 2
Buildings of individual series	75–190	7–63 %	42–79 %
316 series	86–135	19–49 %	54–71 %
318 series	89–146	22–52 %	55–73 %
103 series	81–150	14–53 %	40–73 %
104 series	80–98	13–29 %	50–59 %

Diagram 5: Jelgava apartment building heat saving potential (Source: City of Jelgava)

building statistics (distribution of number of apartments, floors, heating space, living space in a building etc.). The general lowest, highest and average values of consumption parameters and the total number of buildings, heating space, apartments and their type give enough information to estimate the general renovation costs. Precise calculation of the renovation costs is not possible because they are affected by many parameters like the prices in the market, organization of renovation where the costs can be reduced if several buildings are renovated at the same time, etc. The concept must find solutions for effective organization of the renovation process and attraction of investment together with analyses of the heat consumption reduction on the energy supply.

The offered renovation service has to be carefully explained to the inhabitants and apartment owners. The awareness still is low and has to be increased which will take some time; the example of a few good projects has not been enough to gain a wide acceptance for building renovation.

The results of the concept are transferable to other neighbourhoods of Jelgava, in particular the long and medium term city planning documents. The technical and organisational solutions could be transferred to other cities in Latvia as well as to cities in Estonia and Lithuania.

Sources

Jelgava City Council (2011): The main conclusions of the "Concept of energy efficiency increase of multi-storey buildings in Jelgava"

Jelgava City Council (2011): Lessons learnt in work package 4

Jelgava City Council (2011): Concept for EER of buildings and modernization of the supply infrastructure in the Jelgava TA

URB.Energy (2011): Newsletter 4th Issue

3.2
Project: Development of a "Concept for Energy Efficient Renovation of the Building Stock of Jugla"

● Supply ● **Refurbishment** ● User level ● **Network** ● Integrated concept


Image 4: Residential building in Jugla TA
© Riga City Council

Location:	**Jugla Neighbourhood, Riga, Latvia**
Period of construction:	**Till 1950: 8 %** **1951–1960: 12 %** **1961–1970: 67 %** **After 1979: 13 %**
Settlement character:	**182 apartment buildings, public buildings, shops**
Project status:	
Implemented by:	**Riga City Council**
Programme:	**Urb.Energy**

General information
The neighbourhood of Jugla is situated in Riga, the capital city of Latvia. It is the second largest neighbourhood in Riga with 27,250 inhabitants and an area of 14 km^2. The area is characterised by Soviet-era high-rise multi-apartment residential buildings constructed in the 1960s and 70s, although there are also some areas with one-family housing. The ownership structure in the area is almost completely on an individual ownership basis.

Initial Energy Performance
Heat for high-rise apartment housing and public and service buildings in Jugla is supplied via a district heating system. Individual homes and new residential apartment buildings tend to have an independent heat supply using gas or solid fuel. The district heating network is maintained by the local heating company "Rīgas Siltums" but it is relatively old and currently in the process of being renovated. There are two heating plants that supply heat to the neighbourhood.
The buildings in Jugla, like many in Riga and Latvia as a whole, demonstrate a poor energy performance standard with large heat losses and a poor internal infrastructure. This is particularly the case of multi-apartment buildings from the Soviet-era. The average heat consumption of multi-apartment buildings in Jugla is currently 212 kWh/m^2 of heating space annually. The total heating space of multi-apartment buildings in Jugla is 458,200m^2.
Apartment owners can receive 50% co-financing for building renovations but there is currently poor uptake of the scheme. When renovation work is carried out, the work tends to be of a poor quality.

Aim of the Project
The "Concept for energy efficient renovation of the building stock of Jugla" was developed as part of the Urb.Energy project, to initiate the large-scale, high quality, energy efficient building renovation in Jugla and Riga while providing political organisational and technical solutions.
The aim of the concept was to find the reasons and solutions to why apartment owners are not utilising the 50 % co-financing available for building renovations and why the construction work is of a low quality.

Activities

1. The first step to create the concept was to analyse the existing situation. Statistical research of multi-apartment buildings in Jugla (number of buildings, apartments, living area in each series and other buildings, statistics of EER measures) was carried out. Data on the heating supply, hot and cold water, and gas and electricity consumption was analysed.
2. This enabled the formulation of specific recommendations on the quality assurance of energy audits, renovation projects and construction works as well as political recommendations for Local Government.
3. The third step was to do calculations and evaluations of the renovation costs and the effect for the multi-apartment buildings in Jugla.

Results

The "Concept for energy efficient renovation of the building stock of Jugla" was developed. The results of the concept include conclusions, recommendations and calculations.

Conclusions

It was concluded that the ineffectiveness of the existing building renovation organisation process could be attributed to three main reasons:

- The multi-apartment building owners (apartment owners) lack the experience and knowledge how to manage their buildings and how to make decisions in apartment owners' meetings.
- The multi-apartment building owners and the elected members of the board of the apartment owner association of the building lack the experience and knowledge in management, bookkeeping, and attraction of investments. To do these activities in a good quality it is necessary to contract this service from professionals.
- The multi-apartment building owners and the elected members of the board of the apartment owners association lack the experience and knowledge in management and realization of construction works. To do these activities to a good quality, it is necessary to contract this service from professionals.

Image 5: Existing ventilation shafts © Riga City Council

Three renovation programmes were prepared, with varying levels of measures, as it is not always possible to carry out extensive and complex renovation measures in all cases:

- Programme 1: Potential reduction of heat consumption of up to 50 % through the insulation of building exteriors and the replacement of old windows.
- Programme 2: Potential reduction of heat consumption of up to 70 % through the implementation of the measures from Programme 1, as well as the renovation of the heating system, installation of thermo regulators and the implementation of an energy efficient ventilation system.
- Programme 3: Potential reduction of heat consumption of up to 88 % through the implementation of measures from Programmes 1 and 2, as well as additional measures to ensure that the building meets the requirements of a low energy building.

Recommendations

The concept includes 28 recommendations, the most important ones being:

1. To create one, unified product "building renovation" that can be easily understood by the apartment owners (see Diagram 1).

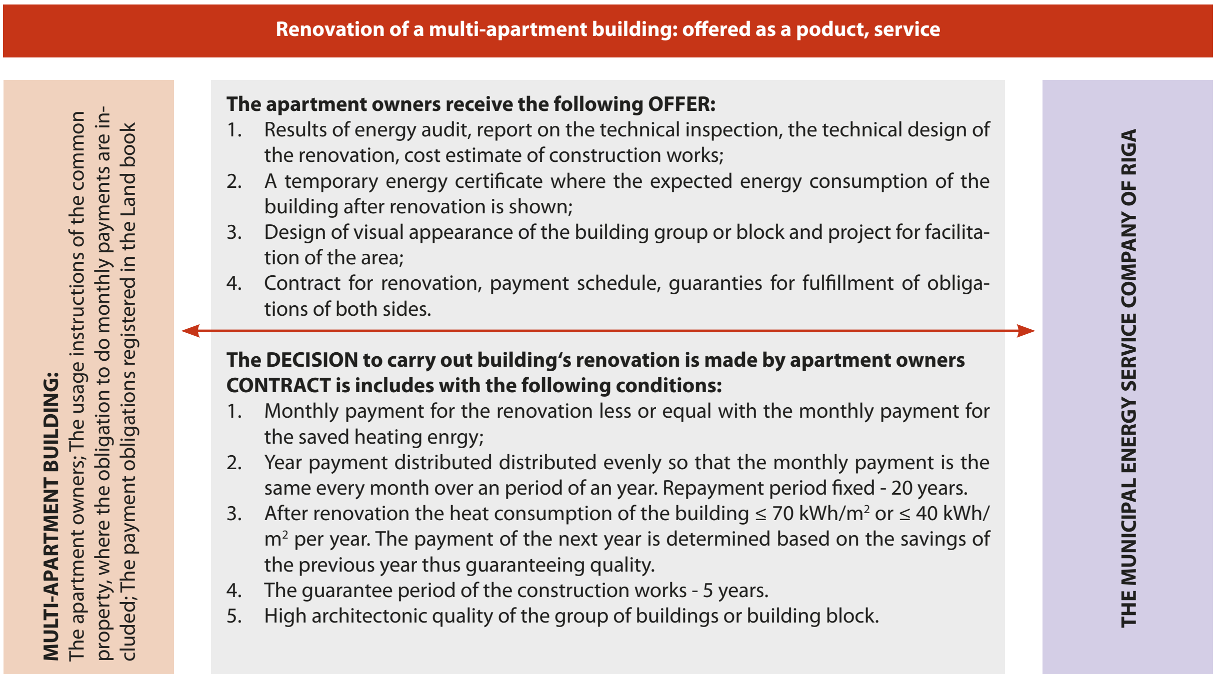

Diagram 6: Conditions for making a positive decision on renovation of multi-apartment buildings (Source: Riga City Council, 2011)

2. The renovation costs should be reduced by carrying out the renovation for groups of buildings.
3. The multi-apartment building renovation should be organized by the Municipality.
4. A specialized Municipal Building Renovation Company (Municipal Energy Service Company) should be established that would cooperate with the municipal building management companies (see Diagram 2). The Municipal Building Renovation Company is planned in Riga (this activity is included in the "Riga Sustainable Energy Action Plan 2012–2020", but a political decision is still to be made).

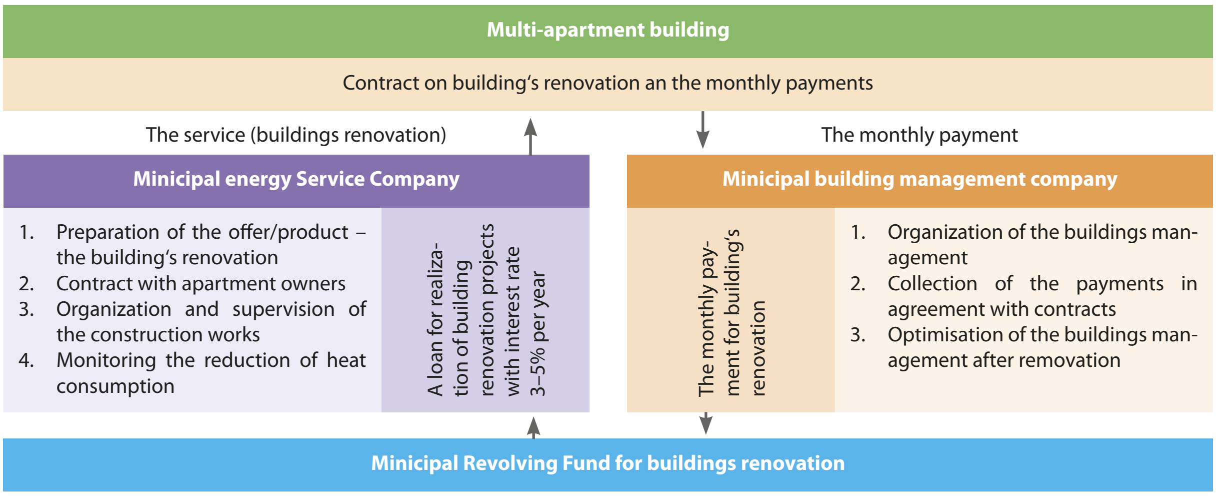

Diagram 7: Functional scheme of cooperation between Municipal Energy Service Company and Building management companies (Source: Riga City Council)

5. To finance large scale multi-apartment building renovation in Riga a financial instrument, a "Revolving Fund", should be established. The Revolving Fund for Building Renovation is also included in the "Riga Sustainable Energy Action Plan 2012-2020" but a political decision is still to be made.

These recommendations were taken into consideration in the development of a "Sample renovation design for a multi-apartment building of Series No. 464". Sample documentation was prepared to show the first steps to be taken in the energy efficient renovation of multi-apartment buildings, using the building series No. 464 as an example. This included the development of a technical inspection report, an energy audit and a renovation technical design. The design outlines several renovation measures such as changing the thickness of insulation on the building's walls, insulating the cellar floor and roof, installing new windows in walls and on balconies and renovating the decentralised ventilation system.

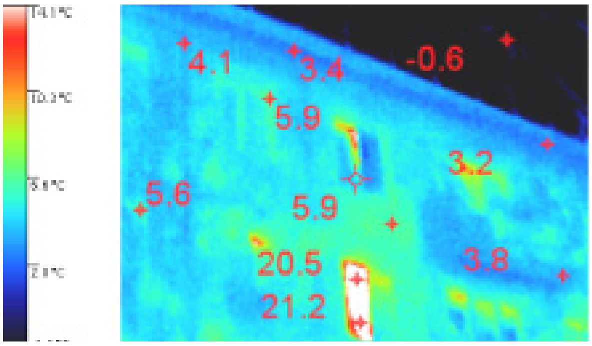

Image 6: Initial thermal performance and building before renovation © Riga City Council

Calculations

The calculations carried out as part of the development of the concept showed that the renovation of all multi-apartment buildings in Jugla would produce annual energy savings ranging from 41-70 GWh (depending on the level of implementation).

Lessons learnt

In Latvia the absolute "must haves" to start a large-scale renovation project are political support (on the municipal and state level) and effective, high quality organisation. The building renovation must be carried out by professionals not apartment owners, i.e. apartment owners should contract the renovation service from a professional municipal or private company.

When a concept for the renovation of multi-apartment buildings in a neighbourhood, city or state is prepared, it can be advised not to focus too much on the details of the existing condition of the buildings (level of deterioration of façade and pipes, percentage of new and old windows, etc.) or too detailed building statistics (distribution of number of apartments, floors, heating space, living space in a building etc.). The general lowest, highest and average values of consumption parameters and the total number of buildings, heating space, apartments and their type give enough information to estimate the general renovation costs. Precise calculation of the renovation costs is not possible because they are affected by many parameters like the prices in the market, organisation of renovation where the costs can be reduced if several buildings are renovated at the same time, etc. The concept must find solutions for effective organisation of the renovation process and attraction of investment together with analyses of the heat consumption reduction on the energy supply.

In order to cut the administration costs the previously decentralised municipal building management companies (one management company for each district of Riga) were recently centralised into one large municipal building management company "Rigas namu parvaldnieks" of which the previous companies are now branches. The new organisation should give an advantage to solve problems on a city scale and organize wide scale measures.

A remaining problem is that the contact between the inhabitants and the city government and politicians has been reduced because the district governments of Riga, which were previously local, were centralised. The representatives of the local government were previously no more than 5 km away; now the physical distance is 10 km from Jugla.

The offered renovation service has to be carefully explained to the inhabitants and apartment owners. The awareness is still low and has to be increased, which will take some time. The example of a few good projects has not been enough to gain a wide acceptance for building renovation.

Political awareness and acceptance of all solutions proposed for large-scale building renovation is still very low and has not significantly changed since 2001 when the first pilot project (Latvian-German) was finished.

The legislation should be prepared to regulate the responsibility of energy auditors, construction supervisors etc. via liability insurance so that the quality of construction can be ensured.

The results of the concept are transferable to other neighbourhoods of Riga and to other cities in Latvia as a whole, in particular the technical, organisation and financial solutions. The technical and organisational solutions could be transferred to cities in Estonia and Lithuania and the specific technical solution of a decentralised ventilation system with heat recovery could be transferred to Germany and Poland.

Image 7: Planned appearance after renovation © Riga City Council

Sources

Riga City Council (2011): Energy efficient renovation of building stock of Jugla: Summary of documents "Concept for energy efficient renovation of the building stock of Jugla" and "Sample renovation design for a multi-apartment building of series no.464"

URB.Energy (2011): Newsletter 4th Issue

Riga City Council (2011): Lessons Learned in Work Package 4

3.3
Project: Model Energy Efficient Refurbishment of three Soviet-Era Buildings in Lida, Belarus

● Supply ● **Refurbishment** ● User level ● Network ● Integrated concept

Image 8: Modernised multi-storey building
© Grodno Executive Committee, Housing Department

Location:	**Lida, Grodno Oblast, Belarus**
Period of construction:	**Mostly Soviet era**
Settlement character:	**Predominantly multi-apartment buildings**
Project status:	**In progress**
Implemented by:	**Grodno Executive Committee, Housing Department**
Programme:	**Urb.Energy**

General information
Lida is the fourteenth largest city in Belarus and is located in the Grodno Oblast. It is a very old city with roots back to the 13th century, but following serious damage in World War II, it was rebuilt with typical Soviet era style multi-apartment buildings. The city has a total of 98,000 inhabitants and 6,250 buildings of which 14.4 % are state owned and 85.6 % private.

Initial Energy Performance
There have been some large renovation activities in recent years to upgrade public spaces in the city centre and to improve the general condition of the buildings. However, a major part of the housing stock in the city still has a poor energy performance. This is due to a lack of sufficient insulation and of individual meters as well as the old condition of electricity generation plants and distribution networks. The majority of buildings in the target area are connected to a district heating system. The major fuel sources for energy generation are gas and local energy sources (such as firewood, peat and sawdust). It is intended to increase the share of cogeneration but there are currently insufficient financial resources to support this. There is currently a lack of knowledge and experience of alternative renewable energy sources. The annual energy consumption of the multi-apartment buildings in the area was 237.7 kWh/m^2.

Three buildings were chosen to be analysed as part of the project. The buildings Sovetskaya St. 43 (Type 1), Tavlaya St. 35 (Type 2) and Mitskevicha St. 24 (Type 3) are typical buildings in Lida. Type 1 is a brick building, meanwhile Types 2 and 3 are constructed using concrete slabs. There are 535 buildings in Lida of the same style. They have a very poor overall energy performance, insufficient internal heating systems and they are not embedded into an overall energy concept of the surrounding neighbourhood.

Aim of the Project
The main goal of the participation in the project Urb. Energy for Grodno Administration of Communal and Housing Services was to receive and share German experience in the sphere of energy efficient refurbishment of residential buildings. There was particular interest in learning new ways of achieving energy saving in housing stock.

Activities
In the framework of WP4 of the Urb.Energy project, the following activities have been implemented:

1. The analysis on energy efficiency for selected buildings with German specialists (completed)
   Grodno Administration of Communal and Housing Services commissioned research on the condition of the external walls and construction of selected houses (Sovetskaya St. 43, Tavlaya St. 35 and Mitskevicha St. 24). The organisation "Grodnoenergosberezheniye" conducted this research, evaluating the condition of external construction of the buildings and made conclusions. After this, the conclusions of the research together with recommendations on complying with German standards of energy efficiency for residential houses, made by German experts from the Energy Agency of Investment Bank of Schleswig Holstein were given to the organisation "Grodnozhilproyekt" for the development of designs and project documentation for the energy efficient refurbishment of the buildings. The recommendations contained three options for energy efficient refurbishment, each with a different level of effectiveness of the refurbishment measures. Due to current Belarusian construction standards, not all of the recommendations from the German experts could be included in the refurbishment projects, for example certain measures like the replacement of heat generators could not be implemented.
   The measures proposed by the German partners contained the following activities (for all options, each option has specific activities):
   - Insulation of exterior walls
   - Replacement of windows
   - Insulation of basement
   - Replacement of entrance doors
   - Replacement of heat generator (district heating, combined heat and power, fossil fuel)
   - Installation of solar domestic hot water with a bivalent cistern
   - Installation of decentralised exhaust air plant with heat recovery and air density validation
   - Replacement of thermostatic valves
2. Implementation of renovation in the housing stock of Lida (still in progress)
   On the basis of the house projects elaborated by "Grodnozhilproyekt", and taking Belarusian construction standards and German recommendations into account, the Lida Administration of Communal and Housing Services started to conduct the refurbishment of the selected buildings. The financing came partly from the funds from the "Dazhynki 2010" festival. The three buildings received partial financing for refurbishment measures from the festival, which meant that they were only partly refurbished. For this reason not all of the recommended measures were implemented.

Results

As part of the project, the three buildings were refurbished to improve the energy efficiency of their external structure. Considering the requirements of Belarusian construction norms and the German recommendations, it was decided to apply the polystyrene isolating material with a thickness of 6 cm. The material was applied to the whole of the building shell. The building on Sovietskaya St. was, however, not isolated with polystyrene; it was only painted with façade paint due to the fact that the building is made from bricks.

The following measures were applied to the buildings:

- Thermal insulation of the walls with polystyrene (thickness 6 cm.) (except Sovietskaya Str. 43 building),
- Replacement of windows (plastic panels were installed),
- Replacement of stairwell entrance doors,
- Replacement of roof covering.

Image 9: Tavlaya St. 35 after refurbishment © Grodno Executive Committee, Housing Department

The buildings acquired not only thermal isolation, but also a new look. They were painted in bright new colours, which made the surroundings look more attractive and improved the appearance of the districts as a whole. This, together with the improved comfort of living and reduced bills, contributed to the approval of the residents. Water and gas meters were also installed in the buildings, which also led to an increase in the amount of savings.

The results of the refurbishment show the level of efficiency of the refurbished buildings. The building in Tavlaya St. 35 showed the best results: during the winter months, the savings were up to 20 % average. The building in Mitskevicha St. 24 had savings of 15–19 % during winter months. The building in Sovietskaya St. 43 showed the poorest results, with savings of only 7–11% during the winter months. This is mainly due to the fact that the building in Sovietskaya Str. 43 was not thermally insulated with polystyrene. Even the poorer results in Sovietskaya Str. are positive because they proved to the Lida Administration of Communal and Housing Services that complex integrated energy efficient refurbishment of the buildings really makes sense and the more activities that can be performed, the bigger the amount of savings that can be achieved.

Inhabitants should be involved in the renovation process through participation and providing information about new renovation technologies and efficiency of renovation measures. The increase of income encourages inhabitants to reduce their level of energy consumption. Price increases of energy resources are also encouraging inhabitants to change their heating systems, use alternative energy sources or to install insulation.

It is very important to develop efficient financial instruments for EER measures before implementation by inhabitants in their houses and flats. Central budgetary financial systems are also important. It is also useful to learn from existing experience for example from best practice examples.

To ensure that the renovation measures are effective, inhabitants should be able to see the direct benefits of a cut in costs that they pay for heating following the refurbishment measures. It is important to explain the renovation project as well as available financial resources at meetings and seminars. New innovation technologies are also important which lead to an increase in energy efficiency, to decrease the cost of refurbishment measures and energy consumption. The results are transferable to other neighbourhoods of the Grodno region (including the technical and some organisational solutions). They are also transferable to other cities in Belarus (good examples, the best technical-economy features). The good practice results, best technical solutions and the best energy saving measures are transferral on an international level.

Sources

Grodno Executive Committee, Housing Department (2011): Description of technical approaches in Work package 4 – Lida Target Area

Grodno Executive Committee, Housing Department (2010): Lessons learnt in Work package 4

Grodno Executive Committee, Housing Department (2011): Concepts for EER for TA in Grodno. Republican Programs of Energy Efficiency

URB.Energy (2011): Newsletter 4th Issue

3.4
Project: Development of a Concept of Energy Efficient Refurbishment of Residential Buildings located in the Area A1MWU, Piaseczno

● Supply ● **Refurbishment** ● User level ● **Network** ● Integrated concept


Image 10: Enhanced cladding for buildings in TA © City of Piaseczno

Location:	**Piaseczno, Poland**
Period of construction:	**1961–1974**
Settlement character:	**Residential with 26 apartment buildings and green open spaces**
Project status:	
Implemented by:	**Polish National Energy Conservation Agency and Piaseczno Municipality**
Programme:	**Urb.Energy**

General information
The town of Piaseczno is situated in the centre of Poland, approximately 18 kilometres south of Warsaw. The target area is located in a rapidly developing district of Piaseczno and comprises 26 apartment buildings and 2,079 inhabitants. Due to its close proximity to Warsaw, the neighbourhood is a typical suburban residential area, characterized by medium-sized apartment buildings with a high number of open green spaces.
There are 26 residential buildings in this area, 24 of which were erected in 1961-1966, and two in 1974. They are generally three-five-storey buildings with a total number of apartments of 1,051 and a total living area of about 40,000 m2. The average area of an apartment is 38 m2 with two inhabitants.

Initial Energy Performance
Apart from twelve refurbished and partially refurbished buildings, the energy performance of the existing building stock is poor with an urgent need for improvement.
All the buildings are constructed using prefabricated concrete blocks and are characterised by high heat transfer coefficient values. This leads to an energy demand for heating of approximately 240 kWh/m^2/year, which is characteristic for buildings erected in the 1960ies and 70ies. At present, the guidelines in force for the design of residential buildings result in values of 100–120 kWh/m^2/year.
In four buildings belonging to housing communities (Szkolna 8, 10, Wojska Polskiego 7, Kusocińskiego 3a), there has been comprehensive thermo-modernisation work conducted in the last three years, including thermal insulation of walls, flat roofs, windows replacement in staircases and in the non-heated basements, doors and central heating system replacement. In these buildings, the energy demand for heating is approximately 100 kWh/m^2/year. Investments in these buildings have been financed by housing communities from their own funds, thermo-modernisation loans and a small subsidy from EU funds in the framework of Interreg IIIB, BEEN project.
In eight buildings belonging to the housing cooperative "Jedność", the energy demand for heating is 100-140 kWh/m2/year. This is because the thermal insulation has been partly improved and the central heating system has been replaced. Nevertheless, the buildings require further work to improve their energy performance.
The neighbourhood is supplied with heat from the city grid operated by PCU Sp. z o.o., a company owned partly by the city and partly a cooperative property, operating a low-temperature boiler room powered by natural gas. The district heating grids belong to Piaseczno Municipality. Domestic hot water is heated in each apartment with the use of domestic gas boilers.

Aim of the Project

On behalf of the city of Piaseczno, the Polish National Energy Conservation Agency (NAPE) developed an integrated concept for the energy efficient upgrading of the neighbourhood. This includes the development of new integrated solutions regarding combined heat, warm water and energy production. Alongside energy, the concept also takes aspects for the general improvement of the residential environment in the neighbourhood into account and will come up with a prioritized package of measures for a general upgrading of the area. The concept will become a local bylaw once it has been approved by the city council.

Image 11: Insulation on the roof of building "Szkolna 10" © City of Piaseczno

The objective was to provide support for energy efficient renovation of 30–50 % of residential buildings with a poor energy performance. According to data of the Central Statistics Office from 2002, more than 85 % of residential buildings were constructed before 1987, in the period when regulations concerning thermal insulation of buildings were quite lenient. In some of these buildings there have been minor renovations, such as window replacements or the modernisation of the central heating system but in most of them there has not been a comprehensive thermo-modernisation renovation or general renovation, which are needed more and more as the time goes by.

To enable the self-organized enhancement of the buildings in the neighbourhood, the concept includes detailed proposals for the technical upgrading of the 26 buildings in the quarter as well as financial supporting resources for the owner associations and housing cooperative respectively. In the frame of the project work all buildings are the subject to an energy audit in order to provide the owner with a solid basis for tailor-made further refurbishment activities in respect to the special conditions in the neighbourhood.

The work to improve the energy efficiency focuses on two main priority areas: the modernisation of the building shells, and on the development of more adequate solutions to the individual hot water supply in each apartment. Due to the specific conditions of the district heating system (seasonal heat production only and difficult property rights), the possible solution could lie in decentralised co-generation devices on building level.

Activities

The first step in the development of the concept was to obtain permission from all building owners to conduct an energy audit on their buildings. This took place in autumn 2009. This was done separately for each of the 18 home owners associations, via their facility managers accompanied by City of Piaseczno officers, during the meetings with the housing owners associations' boards, and with the board of housing co-operative Jedność. The professional auditors from the National Energy Conservation Agency performed the energy audits on each building by December 2009 and submitted a report for each audit.

The aim of an energy audit is to find an optimal scope of action that will decrease the energy demand for heating and domestic hot water production from the technical and economical point of view. Energy audits are carried out in accordance with national regulations. The methodology of an audit includes:

1. Choice of optimal thermal insulation thickness of external partitions. For buildings located in the target area it is at least 12 cm of insulation in order to achieve required R = 4.0 m^2K/W for walls, R = 4.5 m^2K/W for walls and roof
2. Choice of optimal values of the heat transfer coefficient for windows and doors to be replaced with new ones, with U = 1.3 W/m^2K for windows and 2.0 for doors
3. Optimal scope of central heating modernisation, which results from the assessment and includes,

as a minimum, the installation of thermostatic valves on radiators and on vertical pipes

4. Optimal method of domestic hot water production in apartments. This measure covers the replacement of individual boilers by the installation of central domestic hot water
5. Calculation of energy, economic, and ecological results of the optimal variant of thermo-modernisation investment
6. The optimal variant of thermo-modernisation is individualised for each of the buildings in question, and depends on evaluation of the existing condition of external walls, central heating and domestic hot water systems. The scope of optimal variants of thermo-modernisation with their costs and results are presented in a summary table based on the separate energy audits for each building in question. In all buildings the individual gas boilers are to be replaced with the central domestic hot water system through the extension of district heating nodes. The condition for this to take place is that the PCU can provide the hot water supply before the summer. In one of the buildings (Housing Community Szkolna 10) additionally, there are solar collectors planned to support the district heating node in domestic hot water preparation.

The energy audits were presented by facility managers accompanied by City officers to the owners of each building. The boards have to undertake further steps towards implementation of the measures according to the bank requirements e.g. taking decisions on whether to increase the monthly charge for renovation, whether to provide the loan with a subsidy and on ways to repay the loan from own sources (from renovation fund).

Image 12: Insulation of load-bearing walls of building "Szkola 10"
© City of Piaseczno

The results of the energy audits were compiled into a summary table, which indicated the total investment plan for all the buildings including one measure, which is not yet feasible e.g. replacement of individual domestic hot water boilers by central hot water installation. The cost of this measure is relatively high (50 % of average energy efficient refurbishment), because it needs laying new pipes for hot water from existing heat stations to each of the water valves in apartments. This measure was presented to the boards of buildings by facility managers accompanied by City officers in January 2011, and should be treated as facultative until individual buildings owners will take decision on doing this.

Results

The calculated savings from the implementation of the planned energy efficiency improvements range from 17.4 % (Housing Community Szkolna 10) to 51.3 % (Housing Community Szkolna 7), with an average of 35.1 %. Altogether, with an investment of 12.5 million PLN, the inhabitants of all buildings will save about 0.63 million PLN annually. The average payback period for the whole area is approximately 20 years.
Bearing in mind the scale of investments identified in the energy audits, the ownership structure of the real estates, and wealth of the property owners, the following action plan is proposed for the whole area:
I. From the point of view of real estate owners (private owners of apartments, Piaseczno Municipality as a co-owner of some properties, housing communities, Housing Cooperative "Jedność"):

1. Decision making by building owners concerning the implementation of energy efficiency measures identified in energy audits. The process has begun in 8 housing communities. In Housing Co-operative "Jedność", its completion depends on the individual decisions of building owners,
2. Decision making by building owners concerning individual action plans and financing sources they want to use to finance thermo-modernisation. 8 housing communities have decided to use their own resources and loans with thermo-modernisation bonus. Completion time depends on individual building owners' decisions.

II. From the point of view of Piaseczno Municipality, as the coordinator of the process of development of the integrated urban development concept for the area in the framework of Urb.Energy project:
Continuation of actions realised in the framework of Urb.Energy project according to its schedule, that include/included:

1. By 30th June 2010: commission of the integrated urban development plan for the area and presenting it to stakeholders to whom it applies and who will take further decisions
2. In III–IV quarter of 2010: selection of buildings for which the cost of preparing project documentation for thermo-modernisation will be subsidised and selection of contractor to prepare documentation
3. In I–II quarter of 2011: definition of the scope and objective of feasibility study for chosen micro-projects identified in the area and selection of the contractor for this study
4. Continuous actions promoting Urb.Energy project results among subjects concerned with the outcomes.

Image 13: Installing installation on the roof on "Szkola 10"
© City of Piaseczno

Lessons learnt

The concept for an area should be prepared using a bottom up procedure right from the start, e.g. starting from the assessment of investment needs of buildings and economic power of buildings owners. Then, the collected data should be compiled into one common investment project in order to identify the scale and scope of the investment for the whole area. In next step, the financing sources for the investment program should be presented and used depending on their specific requirements. In final step there should be a clear division of tasks between co-owners of the area and the establishment of the investment schedule in order to assure the proper and timely real implementation of the concept. Currently the development of such a concept is not mandatory; they are required only when the relevant legal subjects apply for external financing. The implementation of EER concepts can be facilitated when the subsidies and external financing better recognise the creditworthiness of the owners of buildings.
The project partners learnt that the key condition for starting and implementing the concept is the legally binding decisions of building owners on how to finance the individual investment projects in buildings. There is no need for the city to take action, for example to carry out awareness raising activities. The main problem is where it is possible to obtain softer financing sources than the existing ones. There only is interest to do this so far in one building (Wojska Polskiego 7). In April 2011 the City of Piaseczno indi-

cated this project during elaboration of the feasibility study for JESSICA instrument in Masovian region.
Also, the method of acceptance of renovation plans by home owners associations (voting by simple majority >50) simplifies the decision making process towards the implementation of energy efficient refurbishment of buildings.
Banks in Poland tend to treat home owners associations as good clients, because, thanks to their standardised management procedures, they are seen as being able to repay the loans. This is thought not to be the case with a conglomerate of individual apartment owners.
The results of the project are transferable to other neighbourhoods and countries. The project showed that an energy audit (including the technical and economic assessment of energy saving measures) is the best way to convince building owners to take decisions on the implementation of energy efficient refurbishment measures.

Sources

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URB.Energy (2011): Newsletter 4th Issue

3.5
Project: An analysis of the energy consumption and efficiency of apartment buildings on Seminari Street in Rakvere, Estonia

● Supply ● **Refurbishment** ● User level ● Network ● Integrated concept

Image 14: Multi-storey residential buildings in Rakvere © BUCHA

Location:	**Rakvere, Estonia**
Period of construction:	**1960–1989**
Settlement character:	**18 apartment buildings**
Project status:	
Implemented by:	**Baltic Union of cooperative Housing Associations**
Programme:	**Urb.Energy**

General information

The city of Rakvere is situated in the north of Estonia, about 20 km south of the Gulf of Finland. It is the country's seventh largest city, with 17,000 inhabitants. Seminari Street, the target area in the Urb.Energy project, is a residential street located in the centre of town, with houses from the 1920ies to 1989. They were constructed using a variety of architectural styles and sizes and range from single to five storey buildings, and from wooden and stone houses to typical prefabricated apartment blocks from the Soviet period.

Initial Energy Performance

In the period when the houses on Seminari Street were built, the construction and energy performance requirements were not as high as those of today. The buildings were built quickly using mass-manufactured panels that were not of a satisfactory quality. The thermal conductivity of the external walls (the U value) of many of the buildings is five times lower than modern requirements. The buildings are in need of external insulation.

There are four main types of buildings in Rakvere

1. Period 1971–1980 – Prefabricated small apartment blocks.
    - The exterior walls are constructed using prefabricated smaller blocks and the floors with concrete panels.
    - Non-bearing walls are made of concrete blocks or silicate bricks.
    - Buildings mostly have insulated roof terraces (5 cm of stone dust, sand).
    - Buildings are usually "blocks" with a maximum of five floors without an elevator.

Image 15: Period 1971–1980 Prefabricated small apartment blocks © BUCHA

2. Period 1981–1990 – three floor small panel houses. Prefabricated small apartment blocks.
   - The external walls and the floors are constructed out of prefabricated smaller panels,
   - Non-bearing walls are made of small blocks and bricks,
   - Buildings have flat roofs or roof terraces with insulation (5 cm of fibre glass or flat roof covered with hydro-insulation),
   - Buildings are usually "blocks" with a maximum of three floors without an elevator.

3. Period 1960–1970 – silicate brick houses.
   - The external walls are constructed using silicate bricks and the floors with prefabricated concrete panels,
   - Non-bearing walls are bricks with concrete elements,
   - Buildings have roof terraces with insulation (5 cm of sand, stone dust, or sawdust, some buildings covered with fibre glass insulation),
   - Buildings are usually "blocks" with a maximum of two to five floors without an elevator.

4. Period 1981–1990 – five floor large panel houses.
   - The external walls and the floors are made of prefabricated panels,
   - Non-bearing walls are made from smaller blocks,
   - Buildings have flat roofs covered with 5 cm insulation and hydro-insulation.
   - Buildings are usually "blocks" with a maximum of five floors without an elevator.

All the buildings are connected to the district heating system, which consists of a two pipeline network, with a total length of 17 km. 6 km of this has been insulated and renovated. 51% of the heating company shares are owned by Rakvere city government; 49% are owned by a private enterprise "Fortum".
The specific space heat consumption is about 170 – 180 kWh/m^2 per square metre of living area and the level of electricity consumption is about 50 kWh/m^2.

Image 16: Period 1981–1990 – three floor small panel houses. Prefabricated small apartment blocks © BUCHA

Image 17: Period 1960–1970 – silicate brick houses © BUCHA

Aim of the Project

The aim of the project in Seminari Street is to find the best way to save energy and to transform the area into an attractive living space. The renovated energy efficient multi-apartment buildings will enable the residents to live in a good quality indoor climate and have low energy costs. The project will specifically address the poor energy performance and heat efficiency of the buildings on Seminari Street, not only in terms of technical and economic aspects, but also taking the physical appearance into account. In the long term, it is hoped that the proven economical benefits will show governments the need for refurbishment support funds and attract banks to provide long term, low interest loans.
An audit for different types of residential buildings in the target area will be implemented. This will serve as a basis for the later formulation of recommendations

for energy efficient renovation. The construction projects will not only consist of mere insulation concepts of the houses but also take into account the overall appearance or image of the city by assigning a colour scheme and design principles for the houses. The Rakvere City Government hopes that by investing in the compiling of building project documentation, inhabitants and members of housing associations will be inspired to start carrying out renovation.

Activities

With the support from the city, the project for the redevelopment of Seminari street area was prepared.
An analysis of the energy consumption of the target area buildings in 2005-2010 was carried out. The aim of the analysis is to find out the best solutions for:

- The insulation of the buildings following the principles of architectural value and energy
- The efficiency, cost effectiveness and urban development.

Energy audits were carried out on 18 buildings in the pilot area.
In the next step of the project, renovation projects were compiled in cooperation with the housing associations in the target area. The various options for using renewable energy in the pilot buildings were evaluated and solutions for the reconstruction of the heating and ventilation system formulated. Those building projects will form the basis for future renovation work on apartment houses in order to make the houses energy efficient and adding to a more beautiful urban environment in general. Financial calculations were made for the investments needed to guarantee a high level of energy efficiency, a good indoor climate and high architectural quality of the target area buildings.

Results

It is expected that the average heat consumption will decrease from 180 kWh/m^2 to 60 kWh/m^2. This means that around 100 kWh/m^2 would be a reasonable amount for potential heat savings. The potential CO_2 that can be avoided is 20 kg CO_2/m^2 annually.
The total cost for complex cost for complex renovation is estimated to be around 130 Euros/m^2 per heated area.

In terms of addressing the target area's energy supply, in 2010 it was decided to include Seminari Street in the area to be supplied by district heating. The aim of this was to establish the security of investments in district heating systems and to secure the long term stability of heat MWh price. The Rakvere District Heating Company has also signed an agreement with two boiler houses to supply heat produced from renewable sources (i.e. wood). It is planned for 50% of the heat consumed in the area will be produced from wood-based fuels.

Image 18: Period 1981–1990 – five floor large panel houses
© BUCHA

Recommendations

- Comprehensive renovation includes the insulation of all exterior walls of a building. The heat transfer standard of exterior walls in the Soviet era was about U = 1 W/(m^2*C). Through installing insulating, heat will be prevented from escaping via the thermal bridges and the heat consumption of the building will decrease (U = 0.2).
- To benefit from the decrease of heat consumption, the renovation or technical reconstruction of the existing heating system is relevant. All apartment radiators should be equipped with thermostatic valves to make individual regulation possible.

Image 19: Heating before and after replacement and upgrade with thermostatic valves © BUCHA

- In multi-storey apartment buildings on Seminari Street, the existing heating systems are mostly one-pipe systems and need technical renovation in most cases to two-pipe system. To ensure indoor comfort, thermostatic valves are necessary.

Most of the flat owners have replaced the old fashion wooden framed windows with plastic aluminium framed windows. This has lead to the lack of ventilation in rooms, because the old fashioned windows were designed as part of the ventilation system and supplied fresh air to the building. The new windows fit tightly and the inflow of fresh air is missing. This, together with thermal bridges, creates indoor air quality problems.

- To improve the situation, the ventilation system must be renovated. New technology provides the opportunity to use equipment with heat exchange, so the heat will stay (about 80%) in the room and air is exchanged. A ventilation system with heat recovery and a heat pump is recommended for multi-apartment buildings using hot tap water produced centrally in a heat substation. Heat from exhaust air will be transferred to the hot tap water.
- To make flat owners as decision makers aware about new possibilities, BUCHA and KredEx have been organising awareness and training sessions for flat owners in Estonia for the last 15 years. Associations applying to the complex renovation project design support will be additionally supported by onsite awareness session for all inhabitants living in the building. This process will help owners and inhabitants to take the right decision for renovation.

Lessons learnt

When proposing energy efficient solutions for the houses, an integral approach towards the entire building should be implemented. In order to achieve the actual and maximum cost efficiency, the technical systems, including heating and ventilation should be renewed. New architectural solutions should enable or propose solutions to those issues as well. A standard inner climate should be provided in the rooms after reconstruction works. New solutions are needed for old ventilation systems. The heating system that is predominantly single-pipe should be replaced with a double-pipe system.

The city organised information meetings for housing associations leaders and for apartment owners. As informing of the residents of the target area has turned out to be the key for the success of the project, the town government has hired a consultant who is responsible for organising general meetings in all the housing associations in the target area. The aim of the meetings is to decide whether to start a comprehensive renovation. Awareness campaigns which are targeted towards apartment owners are most effective. At the same time the support structures for energy efficient renovation should be available.

The financial instruments are extremely important especially for countries where the salary level and cost of energy are almost at the same level.

Image 20: Air ventilation problems © BUCHA

Sources

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Baltic Union of Cooperative Housing Associations (2010): Lessons learnt in work package 4

URB.Energy (2011): Newsletter 4th Issue

3.6
Project: Development of the "Energy Chapter" of the Integrated Urban Development Concept for two areas in Šiauliai, Lithuania

● Supply ● **Refurbishment** ● **User level** ● Network ● Integrated concept

Image 21: Siauliai industrial area © Šiauliai City Municipality

	Target Aerea 1	Target Aerea 2
Location:	Lieporiai, Šiauliai, Lithuania	Miglovaros, Šiauliai, Lithuania
Period of construction:	1968–1982	1960–1989
Settlement character:	106 apartment buildings, public buildings and shops	19 apartment buildings, 25 single family homes
Project status:		
Implemented by:	Šiauliai City Municipality	
Programme:	Urb.Energy	

General information
Šiauliai is the fourth largest city in Lithuania with 118,000 inhabitants. The two target areas, Lieporiai and Miglovaros, were selected due to their typical structure and also because of their active communities. Lieporiai is 91 ha in size and has 11,500 inhabitants. It is a typical major housing estate with schools, a park and local shops. Miglovaros is a smaller, purely residential area, being 6.1 ha in size with 1403 inhabitants. Both areas are characterised predominantly by standard multi-storey apartment buildings from the Soviet era.

Initial Energy Performance
An energy audit was carried out by Šiauliai Energija in 2008-2010. It showed the average heating energy consumption for the Lieporiai area as fluctuating between 40 and 101 kWh/m² and for Miglovaros between 46 and 138 kWh/m².
It was found that in the Lieporiai target area, taller buildings have poorer heat energy consumption values, in particular 9-storey buildings with a heat consumption of approximately 80 kWh/m². The smaller, 5-storey buildings with 99-119 apartments were found to have the lowest heat consumption values of approx. 67.4 kWh/m². Six of the buildings were renovated and another six were partially renovated. In the Miglovaros target area, four of the apartment buildings had already been renovated.

Image 22: Roof of Apartment Building No. 156 in Vytauto Street © Šiauliai City Municipality

The buildings in both areas are also often in a poor condition structurally, with the panel buildings showing poorer condition than the masonry ones. The roofs of the majority of buildings have not been repaired and there are many old wooden window frames and open balconies. The ventilation systems in the majority of buildings do not operate efficiently and are almost always idle due to the temperature being the same both inside and outside the buildings. In addition, they remove too much air in the winter which leads to additional heat loss.

Aim of the Project

The main aim of the project in Šiauliai was to ensure that the two target areas develop in an integrated and sustainable way. For this reason, an energy efficient renovation of the building stock is to be carried out alongside measures to improve the living environment. This will be achieved through the development of an Integrated Urban Development Concept (IUDC) for the two neighbourhoods, which will become a binding document once it has been approved by the city council.

While Lithuanian cities generally have low concentrations of sulphur dioxide and carbon monoxide in the ambient air due to the district heating systems, thermal energy consumption is still very inefficient due to the aging heat supply systems and poor thermal condition of buildings. This is the case in both the Lieporiai and Miglovaros target areas, where the energy supply infrastructure, technology and the apartment buildings themselves no longer meet the design, construction and energy consumption norms of today.

Before the project had begun, the residents of both target areas had already started their own activities to enhance the energy efficiency of the buildings; however these varied widely both in terms of quality and complexity. They focussed mainly on activities to improve the energy efficiency of individual apartments, not on whole houses or neighbourhoods. The general refurbishment rate was low. The project aimed to tackle the challenge of upgrading activities in both neighbourhoods to enable the communities and house owners to start their own coordinated refurbishments.

Activities

In the process of creating the chapter "Creation of the Energetically and Ecologically Sustainable Environment" ("Energy Chapter") in the IUDC, several analyses were carried out for both the Lieporiai and Miglovaros target areas. These consisted of an analysis of alternative ways to heat buildings, a feasibility study for heat cost allocation system installation on apartment buildings, and a feasibility study for the usage of renewable energy sources in apartment buildings. The main heat supply network was also analysed in terms of heat loss in both areas.

Image 23: Main Heat Pipeline Scheme in Lieporiai target area
© Šiauliai City Municipality

Results

The "Analysis of Alternative Ways to Heat Buildings" aimed to find a solution to ensure a reliable, environmentally and economically viable supply of heat to an entire urban community. After completing the analysis of potential heat supply options, consisting of a comparison of boiler houses supplying individual blocks to district heating, and the comparison of various fuel sources, including natural gas, liquefied gas, liquid fuel, biofuels and electricity, it was found that in the current climate, it would not be economically advantageous for the residents of both target areas to disconnect from the district heating system. All of the options explored proved to be more expensive than district heating (total cost (including fuel and investment) of alternative fuel sources ranging from 25.82 to 40 ct/kWh compared to 24.2 ct/kWh total cost of district heating).

The "Feasibility Study for Heat Cost Allocation System Installation on Apartment Buildings" investigated the benefits of installing thermostats and heat cost allocation systems on radiators in the apartment buildings. This system would provide the residents themselves with the opportunity to control their heat consumption themselves. It was concluded that in the case of older, unrenovated buildings, it is best to install such a system after or during renovation. The payback periods were also calculated based on an example of a renovated, standard five-storey building with 45 apartments in the Lieporiai target area and on a five-story stone house with 22 apartments in the Miglovaros target area. The economic evaluation of the heat control and accounting system implementation has shown that this is one of the best ways to bring lower heating bills for residents. The payback period is directly proportional to the amount of heat conserved; therefore residents are interested in saving heat and paying attention to the thermal characteristics of their house. Given heat savings of 15-20%, investments would pay off in 3-5 years.

The aim of the "Feasibility Study for the Usage of Renewable Energy Sources in Apartment Buildings" was to analyse the potential of various renewable energy sources in generating heat in an apartment building. Solar collectors were identified as a viable heat production method, with two types of solar collectors: flat plate and evacuated tube collectors. While the evacuated tube collectors were more suited to the latitude climate conditions in Lithuania and more efficient, the study analysed the flat plate collectors due to reasons of investment costs. Calculations were made for a system installed on a nine-story building in the Lieporiai area with 135 residents, 54 apartments and an annual energy consumption of 167,466 kWh. The payback period was calculated to be 16-17 years which is beyond the life of the solar collectors themselves. The economic evaluation of the solar water heating system installation showed that the project is not sufficiently viable in terms of the technical life of solar collectors, and it will not produce substantial economic benefits for the short term. Subsidies received would have a substantial impact on the project performance.

In the "Evaluation of Main Heat Supply Network Modernization", the existing pipeline network was analysed in both target areas and the annual heat loss was estimated (2,954 MWh/year in the Lieporiai target area and 727.4 MWh/year in the Miglovaros target area). It was recommended that some of the pipelines should be replaced with ones with a smaller diameter as their present capacity is greater than the existing need.

These analyses were then used to prepare the chapter entitled "Creation of the Energetically and Ecologically Sustainable Environment" ("Energy Chapter") in the IUDC. This chapter contains conclusions and recommendations for the existing thermal energy infrastructure:

1. Isolation of old pipelines that don't meet the requirements and projected features.
2. There were technological deficiencies because of incomplete pressure in buildings inlets. There were separate sections of pipelines where the diameter could be reduced.

Image 24: Main Heat Pipeline Scheme in Miglovaros target area
© Šiauliai City Municipality

3. The estimated reconstruction cost of district heating pipes in both stocks reaches 15,679 thousand Lt, but 3,279 thousand Lt would be invested in the main pipeline contraction. Ultimate reconstruction of pipelines would reduce the loss of energy by 4,210 MWh/year.
4. When technical heating projects are prepared the renovation drafts, the length of district heating pipelines as well as investments into reconstruction and loss of energy could be reduced. It is highly recommended to prepare thermo-hydraulic estimates evaluating possible changes of pipeline configuration.

5. Strengthened participation of citizens in the decision making process (information in website, organization of meetings, events, etc.).

There are still some major challenges to the future continuation of the project and its results. One major challenge is the residents' attitude towards the renovation process. . There is a lack of motivation for refurbishment among housing communities. The level of awareness of the need for such a project can be seen as low (only 8.64 % of respondents participated in a resident survey). It is difficult to re-plan a territory which was developed and created many years ago and in a different economical situation. The infrastructure is old and causes large thermal losses. The low thermal resistance of walls and windows results in a huge thermal loss.
The results are transferable to other local apartment buildings and neighbourhoods (in particular the technical and organisational solutions). The technical, organisational and financial solutions on the other hand can be transferred to the whole of Lithuania. Some of the technical and organisational solutions could also be transferred to Estonia, Latvia and Poland.

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3.7
Project: Solar thermal facilities combined with district heating and enhanced cladding in Potsdam

● Supply ● Refurbishment ● User level ● Network ● Integrated concept

Image 25: Solar panels with special function
© Parabel Energiesysteme GmbH

Location:	**Potsdam**
Period of construction:	**1955–1965**
Settlement character:	**Residential**
Project status:	**Completed in 2007**
Implemented by:	**ProPotsdam**
Programme:	**Urb.Energy**

General information
This project consisted of the energy efficient application of solar thermal facilities in combination with upgraded cladding and district heating, for a total area of 5,206 m^2 living area, comprising 100 accommodation units.

Initial Energy Performance
The building stock falls into two main groups: block construction buildings from 1965 requiring 160 kWh/m^2a and pre-fabricated buildings with an energy demand of 140 kWh/m^2a. The energy consumption consists of a total of 1100 MWh/a.

Aim of the Project
The company ProPotsdam GmbH intended to exceed the German Energy Saving Ordinance (EnEV) by at least 30% in the field of heat energy efficiency, intending to ensure its status as a role model for alternative energy approaches.
Various measures were to be combined to achieve a high level of energy savings and metering was to be introduced to make these savings visible.

Activities
After carrying out detailed analyses of the actual level of heat energy consumption in the residential housing, various insulation measures were implemented with the purpose of avoiding further energy losses. New window insulation was installed in various parts of the buildings to achieve increased energy savings. Exterior walls, the basement and attic ceilings were supplemented with additional insulation layers. These measures led to a decrease in heat energy demands of around 55 %. To reduce the amount of energy required to heat hot water, a combination of district heating and solar-thermal power was put into use.
A fully preassembled hydraulic station, using solar heat to provide drinking water, as well as for heating, led to an increase in the annual utilization ratio. Whereas ordinary solar facilities store solar heat immediately on collection until it is required for warming drinking water, the solution used in the project in Potsdam employed a different approach: Usage before storage. That is depending on the temperature of the water, the solar-thermal module channels the solar heat to either the drinking water system or to the heating system.
Only if the heat produced is not used or needed instantaneously, it is put into storage.
The heating and hot water allocation systems were adapted in parallel and new energy stores were in-

stalled, the entire system was hydraulically adjusted and enhanced via optimised heat pumps.

Results

The interaction of solar-thermal facilities, insulation and cogenerated district heat produced good results. Heating energy demands were reduced to 47% of prior consumption, which was proven by annual metering in 2010. Compared to the initial 1100 MWh/a for the whole building, the final heat demand amounts to ca. 600 MWh/a.

Sources

Potsdam Chamber of Commerce and Industry, 2011

3.8
Project: Energetic rehabilitation and renewable district heating of monument protected buildings in Prenzlau

● Supply ● Refurbishment ● User level ● Network ● Integrated concept

Image 26: Simulation of final building facade
© keller mayer wittig architekten stadtplaner bauforscher

Location:	**Prenzlau**
Period of construction:	**1900–1918**
Settlement character:	**Residential**
Project status:	
Implemented by:	**Wohnbau Prenzlau GmbH**
Programme:	**Urb.Energy**

General information
The group of buildings in Prenzlau consists of 2 residential houses: one of which is classified as historical monument, which can complicate the implementation of conventional insulation measures. After carrying out an evaluation of the specific circumstancse, it was, however, possible to develop a convincing energy efficient refurbishment concept. The building stock encompasses 25 accommodation units with a total area of 2,888 m^2 and special heating warmth requirements of 195 kWh/m^2a. The project was financed by grants from the KfW and the Federal State of Brandenburg.

Initial Energy Performance
Coal generated individual heat energy was used in the accommodation units, leading to an overall energy demand of 195.2 kWh/m^2a.

Aim of the Project
The main objective of the project was to exceed the level of energy efficiency required by the German Energy Saving Ordinance (EnEV) through the implementation of an integrated spatial energy concept. Additionally one of the key incentives was to demonstrate efficient results, particularly faced by difficult framework conditions, such as the legal guidelines for historical buildings.

Activities
Before the renovation project started, individual brown coal stoves supplied the heat energy, which was eventually superseded by district heating from Stadtwerke Prenzlau public utility company. Half of the total heat energy is supplied by cogeneration and the share of renewable energy sources increased to a comparably high 50%.
Taking into account that energy losses result preliminarily from deficient technical infrastructure, the complete heating and sanitary system was reinstalled and supplemented with new installations of decentralised ventilation plants for every apartment with heat recovery.
Moreover several insulation enhancements were implemented: the building envelope and outer walls were insulated despite having to comply with the strict building restrictions for historical monuments. In addition, the ceiling, roof and cellar ceiling were thermally refurbished, new windows were installed and existing box windows were strengthened.

Results

The final energy consumption before the refurbishment amounted to 195.2 kWh/m^{2}a, which decreased to only 79 kWh/m^{2}a after the refurbishment. The Energy Saving Ordinance requirements were exceeded by more than 50% for historical building stock and by even 10% for modern residential building standards.

Owing to the integrated implementation of the measures, the specific energy demand was reduced by 59%

The project costs amounted to 2 million €, including all building construction measures and plant technology.

Sources

Potsdam Chamber of Commerce and Industry, Summary Prenzlau 2011

3.9
Project: Energetic reconstruction in combination with district heating from regenerative energy sources

● Supply ● Refurbishment ● User level ● Network ● Integrated concept


Image 27: Biomass plant Henningsdorf © KPG

Location:	**Henningsdorf**
Period of construction:	**1950**
Settlement character:	**Residential**
Project status:	**Completed in 2011**
Implemented by:	**HWG and SWH**
Programme:	

General information
The city of Henningsdorf planned and implemented a complete municipal energy concept comprising of various measures in the field of energy efficient refurbishment, as well as changing the energy supply structure to a more sustainable one. Completed in 2011, the measures began 1993 and the housing cooperative HWG and the municipal utilities company SWH were responsible for implementation.

Initial Energy Performance
Residential buildings in the district 'Cohnsches Viertel' of Henningsdorf which is considered here as an example for the whole municipal programme were erected in the 1950s as brick construction buildings with a total living space of 30,436 m^2 spread in 525 accommodation units.
Before refurbishment measures the special heating warmth need amounted to 160 kWh/m^{2}a while final energy consumption totaled ca. 4.870 MWh/a.

Aim of the Project
To exceed the current climate protection aims according to the German Renewable Energy Sources Act (EEG) and the German Renewable Energy Heat Act (EEWärmeG) was the main objective of the programme. Additionally the subsequent measures in the 'Cohnsches Viertel' district were supposed to cover already the majority of energy savings for the whole municipal energy concept.

Activities
Numerous measures were realised during the period of regeneration, concerning the energy supply as well as the upgrading of technical and thermal insulation .
Outer walls were partially insulated (4 cm) combined with other thermal loss preventing measures such as insulation of the top floor ceiling (10 cm) and the insulation of the cellar ceiling (5 cm). Moreover new windows were installed completing the first part of the concept.
Second step was the adjustment of the technical infrastructure with the new heat energy demands. Heat pumps and control engineering/cybernetics were installed or respectively replaced and solar thermal facilities were installed on the rooftops of 5 buildings resulting in a decrease of the heat demand of 10% annually.
Furthermore the building stock was equipped with smart meters in order to align the consumption to the actual specific heat demand.
During the next step of the concept implementation, the public utilities company 'Stadtwerke Henningsdorf' (SWH) was integrated into the project. The district 'Cohnsches Viertel' was connected with district

heating. A block thermal power station with 3 modules was established, a biomass thermal power station was built and a biogas block thermal power station guarantees the increased use of RES for energy supply.

The SWH public utility company invested around 63.45 m € since 1992 for these measures.

Results

As an example for the whole city concept, the implementation in 'Cohnsches Viertel' reached the objectives of the above-mentioned policies while the gradual implementation process and the cooperation between the public utility company and the housing cooperative have to be considered as a transferable success. Notably the buildings under historic protection profited from the refurbishment measures, especially since insulation measures are difficult to implement on historical facades.

All in all, the special heating warmth requirements were reduced by 20% to 129 kWh/m^{2}a just as final energy consumption lowered by 22 % to a total amount of ca. 3,870 MWh/a. CO_2 emission savings amount to 40,000 t/year, which is highly influenced by the enormous share of regenerative energy for district heating, which is 57 %.

Sources

Potsdam Chamber of Commerce and Industry, Summary Henningsdorf 2011

3.10
Project: Biogas for Potsdam

● Supply ● Refurbishment ● User level ● **Network** ● Integrated concept


Image 28: Typical historical building stock in Potsdam city area © Wikimedia Commons

Location:	**Potsdam**
Period of construction:	**Predominantly 1900 –1930**
Settlement character:	**Residential, Public buildings**
Project status:	**Completed in 2010**
Implemented by:	**ProPotsdam, KIS und EWP in cooperation with IHK Potsdam**
Programme:	**Urb.Energy**

General information
In the last few decades, European cities have experienced a wave of refurbishment and modernisation of their historical housing stock. However, numerous buildings still do not meet the legal requirements in terms of sustainable energy supply. Some organisations in Potsdam have carried out specific analyses to help address this problem, taking into consideration the alternative of biogas/ biomethane cogeneration for residential buildings.

Initial Energy Performance
Similar to the situation in Germany as a whole, Potsdam has a large amount of refurbished building stock with a standard energy supply of centralised power generation in combination with decentralised heat conversion. A public utility company provides electricity, natural gas and district heat from the communal grid. Despite this, a group of buildings were identified as being inadequately supplied with district heat, especially inner city listed buildings.

Aim of the Project
Tackling these shortcomings using energy efficiency and biogas or biomethane based cogeneration is a very interesting option for the housing stock in Potsdam. Biogas may be used directly, whereas biomethane (equivalent to natural gas) is fed into the natural gas grid after complex treatment and concentration. Biogas requires complete piping systems to be installed for every CHP unit, making it most suitable in rural areas without a gas grid. Biomethane however can be supplied via the natural gas grid, making this the easier option in urban areas.
As part of the project, analyses were carried out to reveal the cost benefits to Potsdam over a period of 20 years.

Activities
A list of buildings was compiled for systematic analysis. This list included residential buildings, schools and sport halls where direct access was assured. For five properties containing seven showcase buildings, that were selected as being representative, an in-depth on-site inspection was carried out. This produced a complete set of information for each of the buildings containing energy data, heating system data, a site plan, photos, etc.
An appropriate cogeneration design layout was developed for each of the showcase buildings. Based on the specific design, the total investment was calculated followed by an economic efficiency calculation for each of the buildings. Layout and cost calculations of the seven buildings served as a basis to up-scale the

results to the selection of buildings in the area of investigation.
Two different implementation strategies were analysed. As well as the strategy “Complete Cogeneration”, a second strategy called “Economic Cogeneration” was calculated estimating their respective necessary biogas demand, total investment and CO_2 reduction.

Results

The results presented reflect the different levels of evaluation. The showcase results refer to on-site inspections, property-specific design and cost accounting, each complemented with a specific economic efficiency calculation.
It is crucial to point out that the calculations are only estimates and can be affected by various factors such as future price developments and the legal situation. In addition, public buildings (e.g. schools) require detailed on-site inspections, therefore, apart from the school that was analysed as part of the project, no further estimations were made.
Finally the evaluation brings to light that biogas-based cogeneration offers long-term cost advantages in comparison to conventional residential energy supply as well for micro-CHP facilities. Under the defined conditions, economic the integration of CHP can save around 9% in costs.

Sources

Dipl. Ing. C. Luckhaus: Executive Summary - Biogas for Potsdam, 2010.

3.11
Project: New tool to analyse the energy potential of prefabricated buildings – retrospective case study Berlin

● Supply ● Refurbishment ● User level ● Network ● Integrated concept

Image 29: Buildings in Lichtenberg before refurbishment © Archive BA Lichtenberg, Urban planning department

Location:	**Berlin**
Period of construction:	**1875–1920, 1970s**
Settlement character:	**Residential, Commercial, public buildings**
Project status:	**Completed**
Implemented by:	**Archive BA Lichtenberg, Urban planning department (Case Study)**
Programme:	

General information

Kaskelkiez:

The Kaskelkiez in Berlin, officially known as "Victoriastadt", is a residential area in the area of Rummelsburg in the district of Lichtenberg. The area is characterised by buildings constructed before 1920. The whole area was almost completely regenerated after 1990 and renovated in keeping with building protection status. The residential area has around 3,500 inhabitants and has an area of around 187,450 m^2. Most of the buildings were constructed in the period from 1875 – 1920. Up to 1991/1992 the area still was dominated by war related damage (12% poor /desolate, 59% moderate damage, 29% normally usable).

Frankfurter Allee Süd:

Frankfurter Allee Süd is also a residential area in the Berlin district of Lichtenberg. The area has around 10,000 inhabitants, the majority of which live in buildings on a residential estate constructed in the 1970s. The total residential area amounts to 418,500 m^2. Most are prefabricated buildings from between 1970 and 1985.

Initial Energy Performance

Kaskelkiez:

The buildings in Kaskelkiez were partially in a poor structural condition, as well as having a poor energy performance.

The heat supply was primarily decentralised (76% stove heating, 14% gas individual room heaters, 2% gas-storey heating, 8% central heating (coal)). No data is available regarding the supply of hot water, but according to estimations hot water was supplied through 45% coal stoves, 30% electrical storage heaters and 25% gas instantaneous water heaters.

The energy network of Kaskelkiez, which was in a good condition, was completely developed with natural gas. It was upgraded to the greatest possible extent in the 1980's and steel piping was laid. There was no district heating supply, although lines were present.

The specific heating energy demand amounted to 203 kWh/m^2 a. The specific final energy demand amounted to 383 kWh/ m^2 a (final energy demand 319 kWh/m^2 a). This resulted in CO_2 emissions of 108 kg m^2 a.

Frankfurter Allee Süd:

The facades were in need of renovation due to concrete damage and heating and central hot drinking water preparation was inefficient. Heating and hot drinking water was supplied by the centralised district heating network via mainly single-pipe heating systems. The district heating network was completely developed. There was a supply of natural gas but it was only partially used for heating.

The heating energy demand amounted to 131 kWh/m^2a and the primary energy demand to 125 kWh/m^2 a. This resulted in CO_2 emissions of 53 kg m^2 a.

Aim of the Project

The aim of this case study was a retrospective view of the integrated urban development and the possibilities of energy related modernisation of the past twenty years in Berlin´s urban quarters Kaskelkiez and Frankfurter Allee-Süd. In addition, to give an overview of the measurements and results, the case study uses a different and more appropriate method to measure and compare energy consumption data and CO_2 emissions 20 years ago and today and which lead to the figures used below.

New Tool for calculation of energy consumption of buildings

Within the frame of the Berlin Case Study an innovative and transferable CO_2 emissions calculation tool was successfully developed. Using this specific method a precise and adequate value calculation of CO_2 emissions and feasible CO_2 reductions is available. This information functions as a foundation for the efficient implementation of refurbishment measures, since constructional defects and mistakes in financial calculation can be avoided thereby reducing potential risks to a minimum. The spatial calculation results from putting together the built-up floor size and the number of floors using a special conversion factor. Energy parameters have to be obtained from official regulations (DIN 4108-6 / DIN 4701-10) and synchronised with actual consumptions.

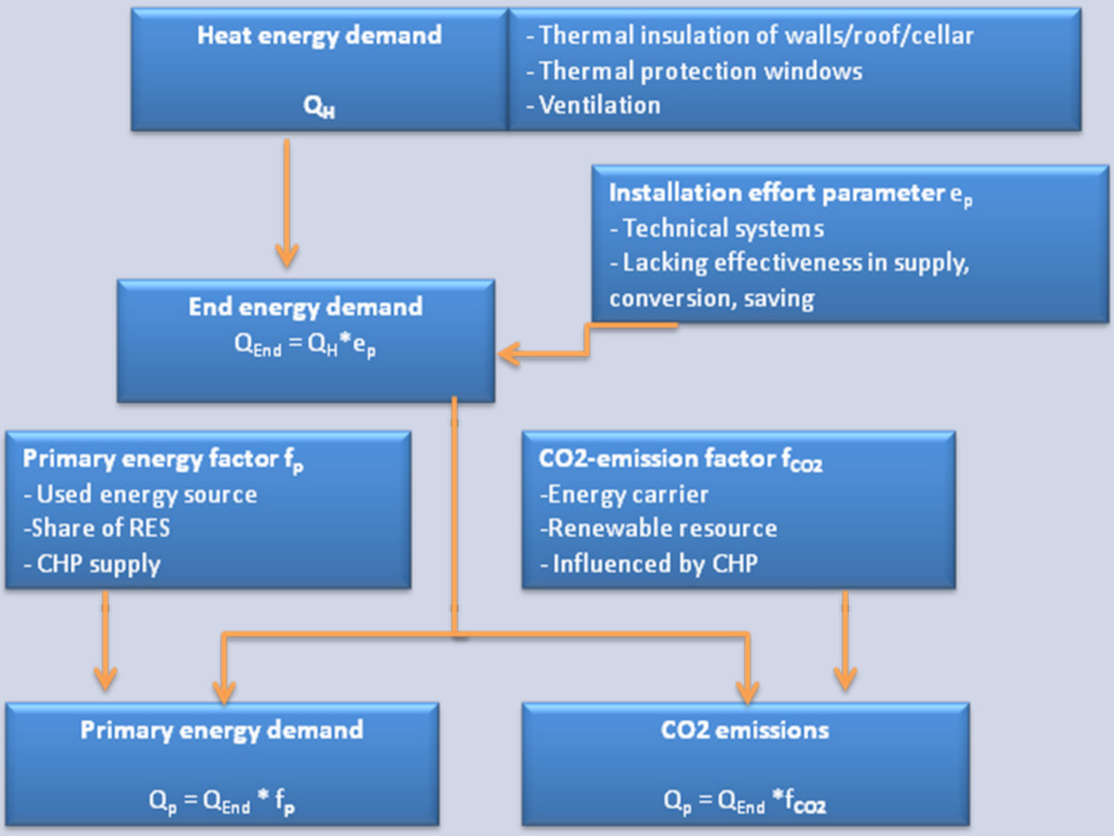

Diagram 8: Calculation tool (Source: BBP Bauconsulting mbH)

The following equations result from this calculation method, leading to precise data that can be used to refurbish buildings in a cost and energy efficient manner. This was shown by the successful implementation in Kaskelkiez and Frankfurter Allee Süd areas.

CO2 emission = Final energy demand × CO2 emission parameter

CO2 emission reduction = Reduced heat demand/ enhanced equipment × Amendment of CO2 emission parameter

Diagram 9: Equations calculation tool (Source: BBP Bauconsulting mbH)

Kaskelkiez:

Decentralised heat generators like stove heating/gas outer wall heating were replaced by central heating equipment with modern low-temperature/condensation boilers, almost completely based on natural gas. Occasionally storey-level gas heating per housing unit was installed, followed by the installation of central hot water equipment and the renovation of leaky roofs, to some extent with insulation of the top ceilings. The roofs were insulated as well as the basement ceilings. Old windows were replaced or refurbished. The facades (stucco facades) were renovated except in cases of historical monument protection where only the rear facade surfaces (courtyard or side wing) were insulated. Renewable energy sources were installed in particular properties (4 properties with solar thermal energy, one property with photovoltaic technology, one property with a biomass furnace (pellets)). Kaskelkiez has an outstanding example of a low-energy building with solar thermal technology at Kaskelstrasse 49 which was renovated in 2005/06.

Frankfurter Allee Süd:

The district heating supply was maintained. The feed points of the district heating stations were modernised, including the hot water preparation. Thermostatic valves were installed, consumption-based billing was implemented and, in case of complex renovation projects, single-pipe heating equipment was replaced by twin-pipe equipment and the supply equipment (ventilation, cold/hot water distribution, electric distribution) was modernised. To reduce distribution losses circulation lines for hot water were also modernised. Also in complex renovation projects, heat insulation of the facades and of the lowest resp. top ceilings were carried out including replacements of the windows as well as renovations of the buildings supply equipment.

Results

Kaskelkiez:

The main part of the buildings were renovated by 2010 (approx. 60 % completely / partially, approx. 15 % basic requirements). Due to newly constructed buildings and extensions, the total area has been increased by approx. 82 %. In residential buildings 80 % central heating with natural gas were installed (15 % storey-level gas heating, 5 % stove heating or other). 100 % of business buildings have central heating with natural gas. Up to 85 % of the hot water supply is supplied by a centralised network using natural gas, whereas 15 % is decentralised (electric). The heating energy demand was reduced to 152 kWh/m^2 a, the primary energy demand to 205 kWh/m^2 a. This has led to a reduction of CO_2 emissions of 32 % to approx. 6.500 t/a.

Frankfurter Allee Süd:

In 2010 nearly all residential buildings were renovated and the office buildings were partially renovated. In the public buildings, the renovation of daycare and high schools are currently being implemented, whereas there a non-energy-related renovation of commercial halls.

In the low-energy building of the housing association Howoge, a decentralised heat and power unit which delivers 175 MWh heat and 85 MWh power annually was installed.

The average emission factor of district heating was reduced from 300 to149 kg/MWh. The total reduction of CO_2 emissions for the whole area amounts to 70 %.

Sources

UrbEnergy: 20 Jahre Integrierte Stadtentwicklung – Fallstudie Berlin, Auszug, WP 3 Urban Development: http://www.urbenergy.eu/fileadmin/urb.energy/medias/veranstaltungen/Berlin2010/Documentation/Conference/BER02ho0_Handout_101018_EN_final.pdf. (12.07.2011)

Urb Energy, BBP Bauconsulting mbH, Center of Competence for Major Housing Estates: Case Study Berlin, Summary, WP 4 Energy Efficiency and CO_2 Emission Reduction.

Further good practice examples

3.12
Former cooperation project between the Senate for Urban Development in Berlin and the Latvian Ministry for Environment and Urban Development

● Supply ● **Refurbishment** ● **User level** ● Network ● Integrated concept

Image 30: 9 storey high rise building © IWO e.V.

Location:	**Riga, Latvia**
Period of construction:	**1990**
Settlement character:	**9 storey high-rise building**
Project status:	**Completed**
Implemented by:	**IWO e.V. on behalf of Senate for Urban Development in Berlin and the Latvian Ministry for Environment and Urban Development**

General information

Ozolciema iela 46/3 Riga Zemgale in Riga is a typical CEE prefabricated building with 9 storeys constructed in circa 1990 and built from lightweight single layer prefabricated concrete panels.

In 1999 the Senate for Urban Development in Berlin and the Latvian Ministry for Environment and Urban Development in Riga agreed to refurbish the building as an energy efficiency pilot project for prefabricated buildings in the EEC. The project was inspired by Latvia's need to address the deteriorating condition of its residential prefabricated housing stock, and by Germany wishing to disseminate its experience in overcoming similar problems in its prefabricated stock in the new Eastern Länder.

Improvements to the building included insulation to the façade, roof and basement ceiling. New windows were added and the heating system was completely overhauled, including new pipe work and the installation of regulating and monitoring equipment. Completed in 2001 and as a result of the improvements, residents' heating bills were approximately halved while comfort improved markedly. Approximately 53% or 50,000 m^3 of gas per year is being saved.

Image 31: Leaking windows before refurbishment © IWO e.V.

Initial Energy Performance

The circa 1990s building has 5562m^2 of floor area comprising 72 rented flats over 9 storeys and is built of lightweight single layer prefabricated concrete panels. Heating 3955m^2, the community-connected heating system comprised a single pipe system that could only be regulated by opening and closing the building's (leaky) windows. Before the refurbishment the building required 155 kWh/m^2a heating energy which equated to 2,442 kg/a CO_2 emissions.

Aim of the Project

The pilot project was intended to establish the technical feasibility of applying the Berlin experience of energy efficient refurbishment to the Latvian context. Its objectives were to implement an energy efficient refurbishment project on a standard type of building in Latvia to address construction problems with the façade. Another aim was to demonstrate that an energy efficiency refurbishment project introducing complex measures could be achieved without rehousing the residents, as well as to achieve a 50 % reduction in heating costs whilst increasing resident comfort levels.

Activities

The building façade received the most visible heat saving changes. Firstly, the building's outer walls were covered with 80 mm slabs of thermal insulation. This was fixed using the latest supporting screen technology and then covered with decorative plaster. This yielded a weatherproof heat shield (guaranteed for 25 years) and significantly reduced the possibility of repair work. 100 mm of thermal insulation was also applied to the roof. The ceiling of the basement was thermally insulated with 60 mm of sprayed foam. The new insulation reduced heat loss through walls, the roof and basement by 65 %.

New double glazed, plastic framed windows were fitted, complete with ventilation channels. These, combined with the new mechanical exhaust ventilation shafts connecting to bathrooms and kitchens, reduced ventilation loss by up to 50 %.

Renovated multi-family buildings in Berlin have shown that if stairwells are also renovated, residents feel especially proud of their building. For this reason, the stairwell of the building on Ozolciema iela was repaired and renovated.

In terms of the heating system, both the space heating and domestic hot water remain connected to a gas-fired thermal district heating station. The heating system in the basement was upgraded with modern heating controls and flow regulation technology to maximise the energy saving potential. In addition, existing pipes in the basement were insulated to minimise heat loss. Radiators in the flats were replaced, incorporating a two pipe system complete with thermostatic radiator valves and heat meters, allowing residents to regulate and monitor heat consumption. This has allowed heating costs to be calculated according to each apartment's heat consumption.

Resident consultation was considered a key element of the project, as it was important to demonstrate that energy efficient high-rise refurbishment could be successfully achieved with minimum disruption to residents – and this would not have been possible without consulting them. Consequently written material was distributed and a series of meetings and consultations took place, organised by the project manager and the German supervisor.

Image 32: Repaired and renovated stairwell © IWO e.V.

Results

A healthier and more comfortable living environment was created with reduced mould due to higher interior surface temperatures and thanks to the new building façade the building was far more attractive on the outside as well. The life of the building was prolonged, as a drier building means less corrosion and decay in the long term.

As a result of the project, around 53 % or 50,000 m^3 of gas is now saved every year. This corresponds to CO_2 emissions reductions of about 1.4 t per apartment per year. The tenants' heating costs have been reduced from € 240 per year to € 120 per flat per year. Ten new jobs were created due to investment in the project. Public awareness on energy efficiency was raised by a dedicated promotional campaign.

Image 33: Ozolciema iela 46/3 Riga Zemgale after refurbishment
© IWO e.V.

This building was successfully refurbished as one of the first pilot projects to be a replicable example of an energy efficient high-rise refurbishment in Latvia.The success of this pilot project led to a wider programme of energy efficient refurbishment for housing stock across Latvia, as well as the initiation of the Baltic Energy Efficiency Network for the Building Stock Project (BEEN Project) and the Urb.Energy project.

Sources

International Energy Agency & EuroACE (2005): Energy Efficiency in High-Rise Refurbishment, Case Study Series, Riga, Latvia

3.13
Project: Wohnungsbaugenossenschaft "Bremer Höhe"

● Supply ● Refurbishment ● User level ● Network ● Integrated concept

Image 34: Solar panels saving 29 tonnes of CO_2 annually © Gustedt/Berliner Energieagentur

Location:	**Berlin**
Period of construction:	**1870s and 1910s**
Settlement character:	**Residential, listed buildings in the style of the 1900s**
Project status:	**Completed 2003**
Implemented by:	**Wohnungsbaugenossenschaft „Bremer Höhe" eG / Berliner Energieagentur**
Programme:	

General information

The "Bremer Höhe" is situated in Berlin, in the district of Prenzlauer Berg, Pankow. The buildings were constructed between 1870 and 1913 and rank among the most historically valuable buildings of the district. Management of the "Bremer Höhe" was taken over by tenants who organized themselves into a housing cooperative and renovated the building complex on their own initiative. A special challenge was the strict conservation requirements. The Berliner Energieagentur carried out measures in 455 residential and 12 business units, covering a total of 32.400 m^2.

Aim of the Project

The aim of the project was to renovate the buildings in the area and to provide them with a modern ecological energy supply.

Activities /Results

The apartments are supplied with heat and electricity by three modern roof heating units; a gas heated boiler plant and combined heat and power modules. For this purpose high requirements of sound insulation are complied with. The performance of the three combined heat and power modules amount to 1 x 34 kW and 2 x 18 kW of electricity as well as 1 x 80 kW and 2 x 40 kW of heat. The boiler plant produces 1 x 531 kW und 2 x 950 kW of heat. The plants can be supervised remotely with automatic failure signal, operation monitoring and smart metering. These measures will save about 450 tonnes of CO_2 annually.
Additionally the Berliner Energieagentur has installed a photovoltaic plant (47 kW) on the roofs of the residential complex. Once more the strict conservation requirements posed a special challenge.
On an area of 341 m^2, 45 mW electricity are produced annually by 232 modules which feed into the local net and receive the required compensation amount. An additional 29 tonnes of CO_2 are thus saved annually.

Sources

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3.14
Project: Concerto-Projekt Hannover

● Supply ● Refurbishment ● User level ● Network ● Integrated concept

Image 35: Modernised residential buildings distributed with geothermal heat © Gundlach GmbH & Co. KG Wohnungsunternehmen

Location:	**Hannover**
Period of construction:	**Predominantly 1950s–70s**
Settlement character:	**Residential, business, public buildings**
Project status:	**Finished by end of 2011**
Implemented by:	**Regional capital of Hannover, Gundlach GmbH & Co. KG Wohnungsunternehmen, Wohnungsgenossenschaft Herrenhausen, Spar- und Bauverein Hannover**
Programme:	**Concerto/act2**

General information

Within the framework of the EU programme Concerto, larger integrated concepts in preferably coherent settlement areas are planned. The focus is on the interplay of innovative concepts concerning energy saving and concepts of energy efficiency, like for example cogeneration of heat and electricity or the implementation of renewable energy.

Seven districts in Hannover (Ahlem, Hainholz, Herrenhausen, Limmer, Nordstadt, Vahrenwald und Vinnhorst) with a total area of 2,160 ha and 70,000 citizens are participating in the project and implementing the corresponding measures.

Initial Energy Performance

The housing stock of the Concerto districts in Hannover consists to a large part of older, poorly insulated one or two family houses with very badly insulated and antiquated heating systems. Due to this there is an enormous saving potential through the renovation and renewal of the technical system of the buildings, which will be supplemented by the change from fossil fuels to renewable energies.

Aim of the Project

The aim of Hannover in the context of the Concerto project is the energy efficient renovation of the building shells of 300–400 apartments. At least the level for new builds in accordance with the German Energy Savings Regulation (Energie-Einspar-Verordnung, EnEV) 2007 should be achieved as well as a maximum requirement of energy about 55 kWh/m^{2}a for another 35 apartments. The aim for public buildings is to halve the energy requirement of heat.

All in all Hannover aims annual energy savings of about 60,000 MWh. Additionally 4,500 MWh of heat and 100 MWh of electricity from renewable sources should be generated each year.

Activities

According to the initial situation, an individually-adapted optimised energy supply for the respective buildings was or is being carried out. Possible measures that are used include: combined heat and power plants, connection to district heating, biomass and solar thermal energy, fuel cell technology and photovoltaic plants on the roofs.

In detail, the most important measures in the Concerto project consist of the thermal improvement of the exterior walls, the roofs or the highest floor ceilings, the thermal improvement of the cellar and the change of the windows. Furthermore the treatment of thermal bridges, an increase of the density of the air and the installation of aerial systems with heat recovery, the optimizing of the heating systems (change of boilers, solar thermal energy, district heating) and the use of photovoltaic plants are part of the project.

These activities are accompanied by measures to raise the awareness of users and to increase their acceptance. Financial efforts were borne by the CONCERTO programme, as well as by KfW loans. Additionally the KfW provided a low interest rate within the frame of a model project called "NEH im Bestand", while in the same instant additional financial support was granted by the proKlima programme.

Results

In 2010 diverse projects were completed in Hannover:

The heating systems of the residential buildings were centralised.

In Ahlem the heating system was changed to a wood pellet plant and in Vahrenwald a district heating system with cogeneration was installed. For this a corresponding part of heat generated from biomass is provided by a power plant of the public utilities. The waste heat of this power plant is used for the drying of wood, which is treated in a biomass distribution place, located within the project.

On the roof of a warehouse, a new photovoltaic plant was put into operation; two others will follow on the roofs of renovated school buildings. Five wood pellet or wood chip boilers are deployed for public buildings and a solar absorbing plant for a swimming pool.

In addition to the completion of further energy efficient renovations of apartment houses, the renovation works of two schools were finished. Another housing cooperative made an application for funding from Concerto and renovated some apartments to improve their energy performance and changed the heat supply to biomass district heating.

In the course of 2011, the last two projects will be completed within the project as well as the renovation of another school with a photovoltaic plant and the integration of a wood pellet plant in a market garden for wintering in Herrenhausen.

Until now savings of 58% - 69% of the heating energy could be achieved, depending on the standard the projects are based on. This is similar to the results of the evaluation of the consumption data of the demonstration projects completed in 2006.

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3.15
Project: Refurbishment of Europe's largest low-energy building in Berlin, Germany

● Supply ● **Refurbishment** ● User level ● **Network** ● Integrated concept

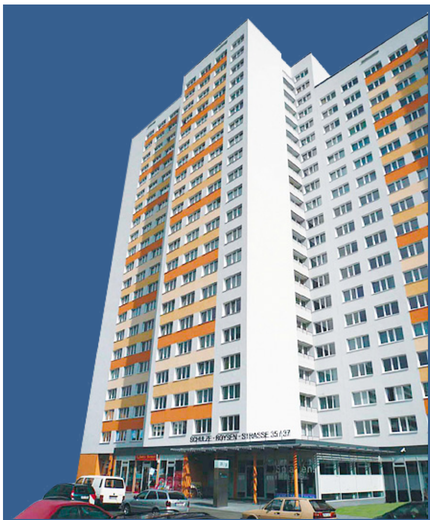

Image 36: High rise building with 296 flats
© HOWOGE

Location:	**Berlin, Germany**
Period of construction:	**1974**
Settlement character:	**Twin high-rise building with 296 flats and 18,000 m² living space**
Project status:	**Completed**
Implemented by:	**HOWOGE**
Programme:	**Niedrigenergiehaus im Bestand**

General information

The housing association HOWOGE refurbished the twin high-rise building at Schulze-Boysen-Strasse 35/37 in Lichtenberg, Berlin and at the same time converted it into Europe's largest low-energy building. The project took place from March 2006 to January 2007 and was part of a national programme called "Niedrigenergiehaus im Bestand" (Low-energy housing in existing stock) from the German Energy Agency (dena), in cooperation with the Federal German Ministry for Transport, Construction and Urban Development. The aim of the project was to test and apply innovative technical methods to save energy.

Initial Energy Performance

An analysis of the building was carried out before the refurbishment to establish the technical faults of the building and to ascertain its primary energy requirement (90.6 kWh/m² a) and its CO_2 emission per kWh (0,162 kg/kWh). It was found that there were thermal bridges in the area of window parapet due to non-insulated window sills and in the area of composite slabs due to lacking insulation. Tests were carried out using infrared thermography and blower door tests, where it was discovered that the closed loggia doors were not airtight (shown via an anemometer and application of mist).

Image 37: Stairwell before renovation © HOWOGE

Aim of the Project

The aim of the project was to increase the attractiveness and level of comfort in the apartments. Through increasing the satisfaction of the residents, such as through cutting down on utilities bills and the need for maintenance, this would help to ensure a high occupancy rate and a steady income of letting fees. As a result the area as a whole would become more socially stable and a better place to live in.

The renovation conducted by HOWOGE should provide a best practice example for the energy-efficient renovation of buildings of this type. It is an example (prototype) of a cost-and energy-efficient renovation, while at the same time, creating a modern living standard for the residents.

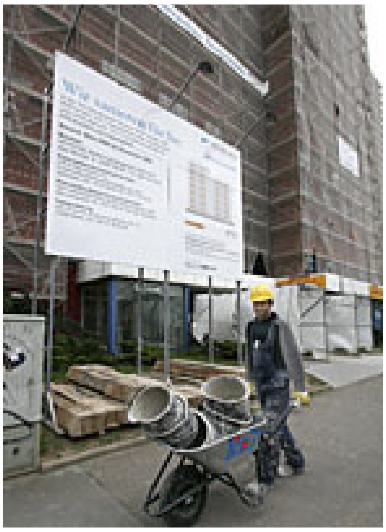

Image 38: Insulation slabs of mineral fibre 12 cm WLG 035, pursuant to DIN EN 18162 © HOWOGE

Activities

The residential building with 296 apartments and over 18,000 square meters living space was completely renovated and modernised from the roof to the ground floor: the pipe work was renovated, kitchen and bathroom tiles restored, apartments' front doors replaced. Unoccupied apartments were completely refurbished; the stairwells and hallways were repaired; the lifts were renovated, as were the commercial units on the ground floor. A shared entrance was constructed for both buildings and a concierge was employed.

The extensive energy saving measures included the installation of water-saving taps and 4.5 litre WC facilities, modern façade insulation, the installation of new heating surfaces and thermostatic valves, the installation of new vinyl windows with three-pane glazing and the installation of a new district heating connection station with a CHP (Combined Heat and Power) module and a controlled ventilation system with heat recovery.

Through the use of a remote controlled district heating connection station using the "HAST-AKKU" system to ensure a steady load on the system, the optimal power input is achieved. In addition, the domestic hot water is heated via a CHP plant and passed through an anti-legionella system (Legioex). The electricity produced by the CHP plant is used to power equipment inside the buildings.

Results

After the refurbishment was carried out, the primary energy requirement of the buildings was 44.9 kWh/ m^2 a. This corresponds with a CO_2 saving of 20 kg/ m^2 a equal to 1,216 tonnes per apartment per annum. The operating costs were reduced by 0.53 €/m^2.

Image 39: CHP connection station © HOWOGE

An insulation concept was developed for the two buildings to eliminate the thermal bridging found in the initial building analysis. The concept included the insulation of the ceiling above the ground floor underneath with 8 cm (inside area) / 10 cm (outside area) mineral wool WLG 035 and a composite heat insulation system on the outside longitudinal and transverse walls on the ground floor with 10 cm insulation WLG 035 lateral / 4 cm insulation WLG 035 front end.

To improve the energy performance of the façade, the outside walls of the entire building were fitted with a composite heat system (12 cm insulation). The new plastic windows have a very low heat transition coefficient Uw of 1.1 W/(m^2K), which is achieved with a triple insulation glazing, also with special properties. The facade elements in the loggia area are also of a high quality with a heat transition coefficient Uw of 1.3 W/(m^2K). All windows are mounted to be airtight according to the latest regulations.

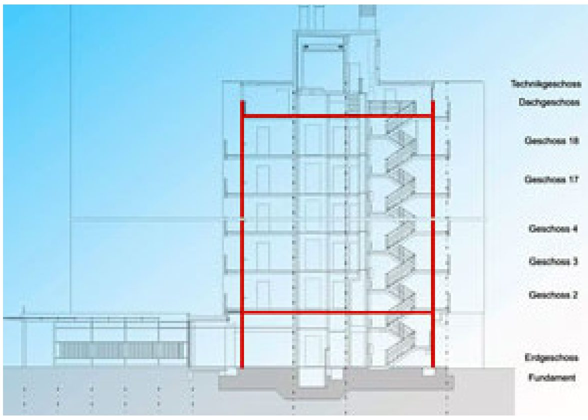

Image 40: Illustration of insulation concept © HOWOGE

Due to the fact that the low-energy standard of a building requires that the envelope of the building is airtight, a controlled ventilation system was installed. Large amounts of energy are lost through the loss of heated air when airing. In order to prevent this from happening, a highly efficient rotational heat exchanger is fitted into the new central air feed and exhaust system for heat recovery. The used air is sucked out of the bathroom and kitchen areas. The majority of the heat energy in the air is recovered in the highly efficient, central heat recovery plant and is used to heat up the fresh air. This pre-heated fresh air is then introduced into all living quarters and is thus made available to the building once more. This also guarantees that the air exchange rate of 1.5 h-1 is observed, which is necessary for reasons of public health. It is still possible for the tenants to air their apartments manually, although it may not be necessary.

The district heating connection station was replaced using state-of-the-art control and management technology for the efficient provision of heating energy and hot drinking water, free of legionella. The system temperatures are reduced to approx. 70/55°C (before renovation it was around 110°C although it varied).

New, modern heating surfaces were installed, better equipped for the lower system temperatures, with thermostatic controls and a short circuit system. The new CHP plant was integrated into the heat generation plant. The electricity produced by the CHP plant is supplied to the building, and is used to light all of the communal areas and to power the ventilation plant. The waste heat from the CHP plant is also used for the production of hot drinking water.

Economically viable solutions were sought to reduce the operating costs of the building, for example toilet cisterns were installed that only require 4.5 l water per flush. This is a saving of 1.5 l and is possible through the use of special water regulation technology. Water-saving taps were installed throughout the building. Special aerators (air-water mixer at the end of the taps) were installed to insert a high amount of air bubbles into the water flowing from the taps. This measure achieves a considerable reduction in water consumption with the same or an even improved cleaning performance (for instance, when washing hands).

The use of electricity has now been reduced to approx. 1/3 of the consumption of conventional neon lamps through the installation of low-energy lamps in all communal areas of the building that are operated by movement detectors in the corridors,.

A shared entrance for both tower blocks was constructed with a generous, glazed lobby and a concierge office. 24h CCT monitoring was installed in the public spaces.

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3.16
Project: Energy efficient urban development – Chances for the building stock due to energy innovations in development areas

● Supply ● Refurbishment ● User level ● Network ● Integrated concept


Image 41: Aerial view of München-Freiham
© Landeshauptstadt München

Location:	**Munich**
Period of construction:	**1960s**
Settlement character:	**Residential**
Project status:	**Conception**
Implemented by:	**Regional capital München, Referat für Stadtplanung und Bauordnung, Hochschule für Technik Stuttgart, Stadtwerke München GmbH**
Programme:	**National urban development politics**

NATIONALE
STADT
ENTWICKLUNGS
POLITIK

General information

The city of Munich is planning an energy efficient development of the new construction area Freiham Nord (190 ha), designed for 20,000 inhabitants. To realize this aim of an energy efficient development this should be combined with the renovation of the stock of the adjoining1960s residential quarter Neuaubing with 10,000 inhabitants. This takes into account that, according to the regional capital Munich, the annual rates of new construction amount to only one percent, therefore the real potential lies in the energy efficient renovation.

Aubing includes the development areas of the 1960s. It is situated at the westerly border of Munich. In the old center it has a rural and in the large residential areas it has an urban character.

The project is carried out in cooperation with the engineering academy of Stuttgart (Hochschule für Technik Stuttgart), the regional capital Munich and the municipal utility company (Stadtwerke München GmbH) of Munich. Moreover the project is a pilot project of the national urban development policy of the Federal Ministry of Transport, Building and Urban Development. The planned start of construction of the development area is in 2014.

Aim of the Project

The aim of the Project is the energy efficient design of the development area of Munich-Freiham and the transfer of impulses of this project to the adjoining settlement area Neuaubing. Especially the concept of the district heating system based on a geothermal heat and power station should be combined with the urban development concepts.

Within the project constructional, urban development and social criteria should be considered thus single-sided energy technical perspectives should be exceeded.

The aim of the project includes multiple aspects as there is the reduction of the consumption of energy and the change to renewable energies. Furthermore every group of inhabitants should profit from the high energy standards. By this the social imbalance between “energy winners” in development areas and “energy losers” in out-of-date building stock should be prevented.

Activities

Considering the realization of the project, the fields of activity of an energy efficient urban development should be identified and then they should be estimated with indicators. Furthermore the CO_2 saving potentials in the development area and in the existing quarter should be estimated, including how these potentials could be exploited. Additionally there should be considered how energy high standards can be realized in economic and social compliance.

Another challenge is the synchronization of the urban development actions, the district heating supply und the energy standards of the existing and the new construction quarters.

To answer these questions a strategic plan should be developed that includes both quarters.

A new geothermal heat and power station situated in Freiham should first supply the existing quarter with renewable energy and in a second step it should supply the new construction area with the residual heat by a low-temperature network.

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3.17
Project: Renovation and CO_2 neutral heat supply in the urban district Haidhausen/Au

● Supply ● Refurbishment ● User level ● Network ● Integrated concept

Image 42: Refurbished buildings "Lilienstraße Nord"© Fraunhofer IBP

Location:	**Munich**
Period of construction:	**1949–1957**
Settlement character:	**Residential**
Project status:	**In planning**
Implemented by:	**GWG Gemeinnützige Wohnstätten- und Siedlungsgesellschaft mbH**
Programme:	**EnEff:Stadt**

General information

The project „Lilienstraße Nord" wants to make the energy supply for four building complexes CO_2 neutral through a combination of renewable energy and a high-performing insulation of the façades. The residential complex in the Munich district Haidhausen/Au which is meanwhile in need of renovation consists of 3-5-storey buildings with a basement and an undeveloped top floor. The 149 apartments measure 40-65m^2 (2, 3 or 4 rooms) and they have a total residential area of about 6.513m^2.

Initial Energy Performance

The residential complex is graded as „in need of renovation".

Currently the apartments are heated with single stoves (coal or natural gas), some with electricity and some with gas floor heating. Warm water is heated locally by gas-fired flow heaters.

Aim of the Project

According to EnEff:Stadt (German program of energy efficiency) the aim of the project is the modernization and energy efficient renovation of the buildings to a certain state by which the need of primary energy falls at least below 50% of the requirement of a new construction. The heat which is additionally needed should be generated from renewable energy or compensated so that finally a CO_2 neutral energy supply can be possible. The structures of the buildings should be conserved and solutions of modern floor plans should be achieved.

In cooperation with the Fraunhofer Institut für Bauphysik (Fraunhofer Institut of Construction Physics) and the Competence Center für Nachhaltiges Bauen (Competence Center of Sustainable Construction) the necessary investments and the expected long-term consequences of such a complex modernization should be analyzed.

Activities

The floor plans of the apartments will be reorganised, smaller apartments will be joined to larger ones and balconies, a top floor and an underground parking will be added. By these measures the total residential area will be increased.

The outer walls of the buildings will be enhanced by an insulation system of Resol rigid foam. The outside façade facing the street will be insulated by a modern heat insulation-compound system with vacuum panels, which has never been carried out to this scale before. The triple heat insulation glass windows will be installed in highly efficient frames.

Due to the low height of the basement rooms, the ceilings could be insulated only with more sacrifice of height. Therefore will be implemented a 2 cm vacuum insulation in the floor reconstruction above the basement ceilings. This will insulate the heated rooms of the building of the unheated rooms in the basement. The addition of another storey in wood construction upon all of the buildings takes on the job of the top building closure.

The future heat supply of four renovated buildings and of the new buildings will take place by a heating central. The apartments will be supplied by near-surface geothermic with a gas-powered compression heat pump.

To guarantee higher inlet temperatures and to meet the peak demand will be implemented another gas condensing boiler. This combination allows an optimized operation of the gas-powered heat pump. To achieve the aim of a CO_2 neutral residential complex a part of the heat will be generated by a field of solar thermal tube collectors.

To realize a low-exergetic approach there will be installed an anoding oxidation plant to prevent a legionella contamination of the drinking water. A ventilation of the apartments was consciously not implemented, the aeration should only take place by the windows. As support of the energy efficient user behaviour (avoidance of long-term aeration) will be implemented window contacts, which stop the heating when the windows are open.

The multiple interactions of the single components in an energy-optimized total system impose very high requirements concerning the control system and hydraulic aspects, especially because of the fact that the energy efficiency relates less on the design condition than on the partial load conditions.

That is why the application of newly developed decentralized heat pumps is favored in this project. These are extremely small pumps, which are fixed directly at the radiator, so that every radiator in the house can be supplied individually with heat. This makes dispensable thermostat valves, throttling valves and the implementation of central heating circuit pumps. There takes place a change from "supply heating" with a central heat pump to a "demand heating". So are warranted a heat supply according to the needs, an improvement of the quality of control and a reduction of the tube net resistances. Results are large savings potentials of electricity and heat. Additionally the heating system is automatically hydraulically balanced. As a consequence the implementation of decentralized heat pumps complements very well the innovative renovation concept of the residential complex.

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3.18
Project: Innovation City Bottrop

● Supply ● Refurbishment ● User level ● Network ● Integrated concept

Image 43: Greenery rooftops in Bottrop
© InnovationCity Ruhr

Location:	**Bottrop**
Period of construction:	**Predominantly 1950s**
Settlement character:	**Residential, trade and public buildings**
Project status:	**Planning phase**
Implemented by:	**Stadt Bottrop**
Programme:	**Innovation City Ruhr, Initiativkreis Ruhr**

General information
The city of Bottrop submitted a conception within the framework of Innovation CityRuhr competition and eventually succeeded in the competitive tendering. During the project parts of the city will be energy efficiently rebuilt and restructured within next 10 years. The spatial scope of the project encompasses 2500 ha in southern city parts and the centre, comprising a total number of inhabitants of 67.000.
Preferably the entirety of the building stock should be refurbished during project implementation, exchanging unmodern boilers and replacing them with heat pumps and solarthermal facilities. Further focuses will be the enhancement of energy efficiency and increased regenerative energy supply, sponsored by Initiativkreis Ruhr, an incorporation of about 60 regional enterprises from the Ruhr region. The project is supported by the Land Nordrhein-Westfalen, and additional financial means will be distributed by the EU.
The Initiativkreis Ruhr expects investments and grants at billion level for the next 10 years.

Aim of the Project
Demonstrating the capability to halve CO_2 consumption in existing urban structures until 2020 is one of the key policies of the project, improving remarkably the living quality of inhabitants in the same instant. The “model city for climate protection” Bottrop should act out as an international role model, and should trigger similar processes in the Ruhr region, as well, with the final target of declaring the whole Ruhr region as a low energy region.

Activities
Ahead of the final site location model calculations have been implemented, taking into account available data stock for the whole Ruhr region and thus generating target objectives concerning CO_2 savings of all in all 50 per cent.
Various action fields will be covered by the model project: firstly heat and power energy consumption should decrease via thermal insulation of buildings, installation of energy-efficient heat systems and fostered use of energy saving electronic facilities.
Moreover the share of RES is said to increase notably, reducing the use of fossil energy carriers as coal, oil and gas in the same instant. Generally the project aspires highest effectiveness in the field of energy efficiency. Supporting measures to reach that target are wind energy, heat and power energy generation from

solar energy, such as biomass, geothermic and process heat, and cogeneration of heat and power.

Environmentally-friendly mobility implies huge potentials, due to the project aims. Thus number and transport ways of persons and assets will be reduced and traffic should reach highest CO_2 saving standards. Therefore important attractions and other highly frequented targets in city areas should be accessible much easier, as well as electric, hydrogen and hybrid cars share is said to increase. Enhancement of public traffic and intelligent logistical concepts round off the project.

In order to lower climate change consequences, such as intense rain or extreme heat periods, rainwater pondages will be installed and greenery is set to be planted on open space areas.

Results

Multiple projects within the project framework are already in implementation, every housing association assured support via refurbishment measures. For instance around 2000 flats were refurbished by the Gesellschaft für Bauen und Wohnen Bottrop (GBB). This housing association further installed photovoltaic panels concerning 8.626 m^2 rooftop areas on multifamily residential buildings leading to CO_2 savings of approximately 830t annually.

City district heating grid extension measures were launched in May 2011, comprising additional connection of 80 accommodation units of 'THS Wohnen' company. Further 825 t CO_2 will amount the expected savings from the cogeneration heat and power supply.

Additionally already four charge stations for electric cars, fed entirely by wind energy, have been installed recently.

Supplementary pilot projects concerning smart metering, user behaviour, and scientific accompagnying were recently initiated and will be transferred into action soon. Thus an innovative wind wheel prototype will enhance the city sphere, as highway noise protection walls will be covered with solar modules.

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3.19
Project: Energy efficient refurbishment in „Märkisches Viertel“

● Supply ● Refurbishment ● User level ● Network ● Integrated concept

Image 44: Europe's largest low energy high rise area © GESOBAU

Location:	**Berlin**
Period of construction:	**Predominantly 1963–1975**
Settlement character:	**Residential, public an business**
Project status:	**in implementation**
Implemented by:	**GESOBAU AG**
Programme:	**Bund-Länder-Programm "Stadtumbau West"**

General information
The quarter "Märkisches Viertel" was erected between 1963 and 1975. Embracing a total area of 3.2 km^2 approximately 16,400 accommodation units, 11 school buildings, several entertainment and cultural venues, and the city quarter centre "Märkisches Zentrum" were built. Largest housing association is Gesobau, which owns 15.200 flats and 90 trade units.

An IUDC implying energy efficient refurbishment shall take place in "Märkisches Viertel" making the neighbourhood act as a role model in that section. For the first time housing associations, energy suppliers and the federal state of Berlin fuse their expertise and financial means by renewing a complete large residential estate.

The foreseen measures have partly been transferred into action, whereas the project aspires its final completion in 2015.

Initial Energy Performance
According to Gesobau there is decisive need for action in energy efficiency issues, since the building stock already exists for 40 years.

The majority of facades and roofs is lacking highest standards and requires thermal insulation measures, in order to lower final energy demand and vice versa unnecessary financial utilities. Numerous flat ground plans fail to satisfy specific demands and renewal of technical facilities on building level call for action, too.

Aim of the Project
Gesobau currently refurbishes around 13.000 accommodation units from the 1960s and 1970s, targeting to establish the biggest German low energy urban settlement area.

The final benchmark should strive to undercut the EnEv 2007 energy policy for modern buildings for at least 30%.

Modernisation measures will entail a reduction of heat energy demands and henceforth halve CO_2 emissions from 40.000 to 17.000 tons annually. The remaining energy demand prospectively will be generated by an already designated biomass heat plant, leading to further effectiveness in terms of ecological contributions. Until 2015 Gesobau intends to refurbish 2000 to 3000 flats annually. Finally the interplay of enhanced energy supply and refurbishment measures will shapeshift the initial building stock into the first German large settlement area with a CO_2 neutral energy footprint.

Activities
In order to accomplish the set objectives various measures, such as exchange of existing windows, insulation of buildings, installation of upgraded heat-

ing equipment or modernization of general building technique, will be implemented. Furthermore until winter 2011 the existent gas-fed block heat plant is planned to be transformed into a biomass CHP-plant, thus supplying major parts of "Märkisches Viertel" with heat. Thermal output decreases from 182 to 119 MW are eventually expected.

For intelligent solutions urge for integrated holistic concepts, the user level has to be taken into consideration, as well. That is, in the case of "Märkisches Viertel", providing advice and guidance to tenants for the sake of individual energy savings via on-site communication and installation of smart metering, thus enabling better and transparent controlling of private energy consumption habits.

Results

An already completed pilot project established successful renovation of 538 flats with a total dimension of 28.800 m^2, supplementing building envelopes with a polysterol-based thermal insulation system leading to a final thickness of 120 millimetre facade and cellar ceiling insulation. Wooden windows were replaced by synthetic material, the pipe system was insulated and special two-pane glass insulation round off the implemented measures.

Primary energy demand amounts to final 49.52 kWh/m^{2}a (before 171.49 kWh/m^{2}a), signifying energy savings at the amount of 71% and an undercutting of the EnEv policy by 39%. Apart from the pilot project Gesobau AG has to its name successful refurbishment of more than 5.000 flats until end of 2010, anticipating the status of "Märkisches Viertel" as the biggest low energy settlement area in entire Germany foreseen for the year 2015.

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3.20
Project: Energy efficient refurbishment of the Prae-Bau Siedlung in Dortmund-Mengede

Supply **Refurbishment** User level **Network** Integrated concept

Image 45: CHP plant © Energieagentur NRW

Location:	**Dortmund**
Period of construction:	**1961–1964**
Settlement character:	**Residential**
Project status:	**Completed in 2004**
Implemented by:	**Dogewo – Dortmunder Gemeinnützige Wohnungsgesellschaft mbH**
Programme:	**KfW- Förderung**

General information

The Prae-Bau- Siedlung in Dortmund-Mengede was constructed in 1961–1964 using prefabricated building materials. There are 17 four-storey buildings and one seven-storey building with 350 residential units and a living area of a total of 25,757 m^2.

Initial Energy Performance

According to Dogewo, the annual heating energy demand amounted to a total of 3,042 MWh before the renovation.

Heat was provided via an outdated heating system with natural gas-fired boilers and a district heating network, both of which had inadequate insulation and leakages. Water was heated in each individual apartment using both electricity and natural gas. In addition, the building envelope has a lack of heat insulation, which presented the potential to make enormous savings.

The kitchens, bathrooms and balconies were also in need of modernization, which presented additional possibilities for improving energy efficiency. Only the apartment sizes and floor plans did not need to be changed, as these still met with modern requirements.

Aim of the Project

The aim of the modernisation was to create a concept that saved energy, was visually appealing and economically viable. The tenant turnover should thus be kept permanently low, the service charges dramatically reduced and pollutant emissions reduced.

Activities

The best solution was to retain the central heating system. In future the hot water supply can be incorporated into the system, so that the use of climate-friendly combined heat and power (CHP) is possible. To reduce the total heat requirement of the housing estate, thermal insulation measures were planned.

To generate power, the old boilers were replaced by two natural gas-powered cogeneration plants with a total capacity of 384 kW heat and 248 kW electricity. These can provide about 65% of the required heat. During periods of peak loads, there are two natural gas-fired low-temperature boilers, each with 895 kW and a storage capacity of 5,000 liters.

Around 3,000 metres of new district heating pipelines have been laid to supply the buildings with warmth via 46 connecting stations. The refurbishment of bathrooms and kitchens allowed the instalment of new pipes and the hot water supply in the individual houses were centralised. Water is now heated in the hot water tank on the ground floors. Comprehensive insulation was installed in the 17 four-storey buildings. The roofs were insulated, the exterior walls were given a thermal insulation system and new windows with heat-insulating glass were installed.

Results

The redevelopment of the settlement began in autumn 2003 and was completed in late 2004.
The annual heating energy demand following the restoration is only 1,842 MWh. The actions carried out save around 40% energy and reduce CO_2 emissions by 55 kg/m^2 living space according to the DoGeWo. This represents the prevention of more than 1,400 tonnes of CO_2 per year.

Sources

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3.21
Project: Energy-efficient renovation of the Weegerhof housing estate of the Spar- und Bauverein Solingen eG – district heating from cogeneration

● Supply ● Refurbishment ● User level ● Network ● Integrated concept

Image 46: Weegerhof quarter © Spar- und Bauverein Solingen

Location:	**Solingen**
Period of construction:	**1928**
Settlement character:	**Residential**
Project status:	**Implementation, almost completed**
Implemented by:	**Spar- und Bauverein Solingen**
Programme:	**KfW loan**

General information

The Weegerhof housing estate of the Spar- und Bauverein Solingen eG consists of around 600 residential units. 450 of these were included in the renovation concept to improve their energy performance.

The project covers a net living area of around 28,000 m². The housing estate is important due to its history dating back to 1928. Although the buildings are not protected as listed buildings, the Spar- und Bauverein Solingen eG have categorised the settlement as being worthy of listed status.

The energy-efficient renovation is being carried out in six building phases over a period of 8-10 years.

Initial Energy Performance

Before the renovation work began, the Spar- und Bauverein Solingen eG acknowledged in an annual report in 2005, that the estate has a poor condition of technical infrastructure, such as gas and water pipelines that are in urgent need of renovation and a high demand for building renovation to improve energy performance.

The heat supply was inconsistent, which meant that the apartments still contained everything from coal-burning stoves to night storage heaters.

Aim of the Project

The aim of the project was to comprehensively renovate the housing estate. The work commenced in 2006. Rather than carrying out construction measures individually, the project took a more comprehensive approach of an energy concept for heating, hot water and electricity, based on the district heating network with a cogeneration plant and a high standard of building insulation. The plan was to completely renovate the buildings on the estate according to new building standards of the German Energy Savings Regulation (Energie-Einspar-Verordnung) and to optimise the water supply and wastewater disposal in the individual blocks of houses.

The aim is to completely renovate the housing estate to improve its energy performance by 2012 and to prevent 1,550 tonnes CO_2 from being emitted each year.

Activities

It is planned to completely renovate the buildings on the Weegerhof estate according to new building standards and to install insulation according to the Energy Savings Regulation (Energie-Einspar-Verordnung).

In addition, since November 2006 the estate has been supplied with heat and energy from a highly efficient combined heat and power (CHP) cogeneration plant. The CHP plant is supported by a 460 kilowatt gas-fired boiler which helps to cover peaks in power demand. From the so-called "old wash house", the heat is transported through a 400-metre long district heating network into the flats.

When a tenant moves in, they are provided with information on the correct way to heat and ventilate their apartments.

Results

In early 2010, almost half of the flats (around 220) in the Weegerhof estate had already been completely renovated. The flats were connected to the district heating network in a series of stages. Within the year, a further 68 residential units were connected to the network.

It is planned that the large-scale modernisation of the traditional estate Weegerhof will be finished by the end of 2012. In March 2010, it was estimated that energy savings of 30 % had been achieved.

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3.22
Project: Solar Community Köln-Riehl

● Supply ● Refurbishment ● User level ● Network ● Integrated concept

Image 47: Residential building of the Solar Community © Erbbauverein Köln eG

Location:	**Köln**
Period of construction:	**1926–1928**
Settlement character:	**Residential**
Project status:	**Completed in 2004**
Implemented by:	**Erbbauverein Köln eG**
Programme:	**50 Solarsiedlungen in NRW**

General information
The housing area is located in the district Riehl in Cologne. The area consists of 14 apartment buildings with a total of 112 residential units that were built in 1926–1928 by the Erbbauverein Köln eG, which is still the owner today. In 2001 the Erbbauverein began to improve the energy performance of the housing area and to rebuild it as a "Solar Community". The construction works were completed in 2004.

Initial Energy Performance
Before the work began in 2001, the buildings were in urgent need of renovation: from leaking roofs to gaps in the buildings' insulation, from insufficient noise insulation to outdated and inefficient technical equipment. In addition, the flats had outdated floor plans and furnishings. The heat for around 50 % of the flats was generated by electrical heaters and by solid fuels. The final energy demand was around 175 kWh/m^2 per year. This is equal to 1,630 MWh or 420 tonnes of CO_2 emissions (50 kg/m^{2}a).

Aim of the Project
The project aimed to address these shortcomings. The buildings' insulation and sound insulation was improved and the buildings' energy performance was brought to a high quality standard such as that for a new build. This led to a reduction in operating and heating costs as well as to a reduction of impact on the environment. The floor plans of the apartments were also altered, while not affecting the city's landscape.

Activities
To insulate the façade, a 150 mm thick layer of composite thermal insulation and a colourful top coat were applied to the external walls, in keeping with the historic landscape of the city. The roofs and cellar ceilings were also insulated (with 350 and 120 mm respectively). In addition, well insulated windows and doors with double glazing were installed. The balconies were replaced by thermally decoupled constructions to reduce thermal bridges.

The technical equipment was optimised through the installation of gas central heating (condensing boiler), which also heats water, and through the installation of cold and hot water metres and heat metres to allow residents to monitor their energy consumption. The consumption is monitored via radio modules, which removes the need to read the metres individually each year. The electrical installations were completely replaced and the water supply and waste water removal pipelines were

replaced taking all possibilities to save water and energy into consideration.
The provision of hot water uses about 50 % of the 260 m^2-large collector area of the solar thermal system that has been installed on the roofs orientated to the South-East and South-West.
In addition, the planned changes to the floor plans as well as improvements to the sound insulation were carried out. 24 loft apartments were also built. One storey apartments on the ground floor and duplex apartments were also created. Each loft apartment now has a roof terrace.

Results

Since 2005, the energy produced by solar power and gas consumption have been monitored regularly.
The heat yield of the solar thermal plant was 99 MWh in 2006, which was significantly more than the expected amount of 85 MWh. Around 68 % of the hot water was heated by solar power in 2006, which exceeded the expected amount of 55 %.
The measured consumption values corresponded to calculations. The renovation reduced the heating demand by more than 70 % to 47 kWh/m^2 per year, or, in absolute terms, to a total of 650 MWh per year. 300 tonnes CO_2 will be saved each year from heating and hot water, which is equivalent to a reduction of 75 %.
Due to the ongoing quality assurance, some of the facilities were adjusted in their first years of operation, which lead to further savings.

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3.23
Project: Heidelberg „Wohnquartier Blaue Heimat“

● Supply ● Refurbishment ● User level ● Network ● Integrated concept


Image 48: Low energy buildings "Wohnquartier Blaue Heimat"© GGH Heidelberg

Location:	**Heidelberg**
Period of construction:	**1920s and 1950s**
Settlement character:	**Residential, old buildings, partially listed buildings**
Project status:	**Completed in 2007**
Implemented by:	**GGH Gesellschaft für Grund- und Hausbesitz mbH Heidelberg**
Programme:	

General information
The residential area is located in the district Handschuhsheim in Heidelberg and is an example of modern urban planning from the 1920s. It was built in 1927 and 1951 and comprises a total of 155 apartments and ten single-family semi-detached houses. With the GGH as leading partner, the "Blaue Heimat" was renovated as part of the pilot project "Niedrigenergiehaus im Bestand". The project was accompanied by the Energie-Agentur (dena) (German Energy Agency) and the Ministry of Environmental Protection, Trade and Energy of the city of Heidelberg and funded by the Kreditanstalt für Wiederaufbau (KfW).

Initial Energy Performance
The building materials, energy and hot water supply were out of date according to GGH Heidelberg, the thermal insulation was poor or missing, resulting in high operating costs. The floor plans did not meet with the standards of today due to the partial lack of bathrooms as well as the outdated room layout.

Aim of the Project
In addition to improving housing quality through addressing the structural and spatial deficiencies, to making the structure of the flats more heterogeneous, to creating new floor plans and types of apartments and to increasing the living area through adjusting the roof and balconies, the aim of the renovation work begun in 2004 was to create a climate-neutral building complex without use-related CO_2 emissions.
The primary energy was to be reduced by 80 %, the heating energy demand by 87 %. These numbers are significantly better than required by the current German Energy Saving Regulation (Energieeinsparverordnung, EnEV) for new builds.

Activities
The project's main activities included the energy efficient renovation of the building envelope, the installation of energy saving equipment and the installation of ventilation systems with heat recovery. Composite thermal insulation was applied to the façades and insulation (up to 28 cm thick) was also applied to the roofs and ceilings. Triple glazed windows were installed and the south-facing windows were made larger. Balconies were rebuilt to ensure that they were thermally decoupled from the main building structure. Alongside the central heating and hot water supply, a ventilation system with heat recovery was installed that could be operated individually. Laundry drying rooms with an efficient ventilation system were also created.

To generate electricity and heat, a cogeneration plant was installed, which operates on the principle of combined heat and power generation. A photovoltaic system was also installed.

The tenants will be informed about the energy efficient use of technology in their homes in detail.

Results

The first construction phase (55 residential units) was carried out in October 2005. In the first two years of operation since the building was modernised, the intended energy savings were achieved.

Through the synergy created by building insulation, innovative technology and other ways of saving energy, the primary energy use for heating and electricity was reduced from 438 kWh/m² per year to just 100 kWh/m² per year. In total, this represents a reduction of 947 MWh of primary energy. The CO_2 emissions of the apartments have been reduced by 79%.

The residual energy required is obtained from renewable sources from a wind power company, i.e. is CO_2 neutral.

However, the ventilation heat loss was measured as being too high. This was due to tenants using windows to ventilate their apartments in spite of the technical ventilation system. The GGH Heidelberg is now providing training courses and events to explain the technology to the tenants. Special features of the apartments and the importance of a change in behaviour will be included in the training, with the aim of reducing the heat loss.

The whole building complex was certified as a "ZeroHaus" (Zero House) residential building in a multi-stage certification process. The process is based on a holistic approach to energy saving regulations. On this basis, it sets more stringent limits. The certification includes monitoring of the planning procedure and the reconstruction measures, in addition to achieving energy savings.

Sources

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3.24
Project: Integrated District Energy Concept Karlsruhe-Rintheim

● Supply ● Refurbishment ● User level ● Network ● Integrated concept

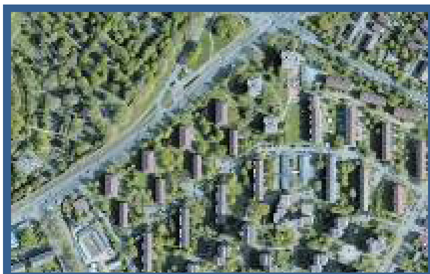

Image 49: Aerial view of the district Karlsruhe-Rintheim © Stadt Karlsruhe, Liegenschaftsamt

Location:	**Karlsruhe**
Period of construction:	**1954–1974**
Settlement character:	**Residential**
Project status:	**In implementation**
Implemented by:	**Volkswohnung GmbH Karlsruhe**
Funding programme:	**EnEff:Stadt**

General information

In 2009, the implementation of the model sustainable district concept began in the residential district of Karlsruhe-Rintheim. The district that is 0.25 km^2 in size contains 34 buildings with a living area of around 75,000 m^2. 86 % of these are owned by the municipal housing company Volkswohnung GmbH Karlsruhe.

The buildings were constructed between 1954 and 1974. Nine of the thirty buildings owned by Volkswohnung GmbH were renovated between 1998 and 2001. Two more were renovated in 2007 and 2008 and three buildings have been partially renovated. Sixteen have not yet been renovated.

Initial Energy Performance

There is a typical post-war large housing estate with correspondingly poor energy performance in the northern section of the district. The area in the centre of the district is from the 1960s/70s. According to EnEff:Stadt, although the heating equipment was relatively modern, the energy standard was not significantly better. In the south of the district, there is a primary and a secondary school. There is mainly gas central heating, gas single-storey heating, coal ovens and electric hot water heaters. A district heating network is under construction.

EnEff:Stadt certified the district as having a high need of refurbishment due to the building ages and the technical quality that is no longer contemporary. 53 % of the 30 buildings belonging to Volkswohnung GmbH were classified as being in urgent need of renovation (figures from 2009).

The gas consumption of the buildings is known, unless individual ovens are used. The hot water demand is not calculated separately. Depending on the level of redevelopment, the gas consumption of the buildings varies greatly and is between about 60 kWh/m^2 and about 220 kWh/m^2 living space. The renovations that have been carried out so far demonstrate a level of saving of 40% to 70% heating energy.

In 2007, the gas consumption of all 30 apartment buildings of Volkswohnung GmbH was 9,040 MWhHs per year according to EnEff:Stadt. Before the renovation began in 1997 the annual gas consumption of these buildings was 10,500 MWhHs, after the second renovation phase (in 2009: 10 of 30 buildings renovated) the amount is 8,460 MWhHs. In 1997, the total annual heat demand of all buildings in the area for heating and hot water was 14,200 MWh. By 2009 this had been reduced to 11,470 MWh per year through renovation already carried out.

Aim of the Project

According to EnEff:Stadt, the aim of the project is to minimise the use of primary energy and CO_2 emissions while keeping the project cost effective. The target of the project is to achieve reductions of at least 50 % to 80 % primary energy and CO_2 emissions.

All buildings that have not yet been renovated, or that have only been partially renovated should be modernised by 2015 according to various renovation standards and using different technical equipment. Four new buildings will also be constructed. This is so EnEff:Stadt can obtain a relatively independent view of the development of energy prices.
In addition, a district heating network will be set up, supplied by a cogeneration plant and using heat recovery, which should be made active in 2011. The buildings will be connected in steps. Volkswohnung GmbH will monitor the energy efficiency of the existing heating plants using an energy management system and improve them if necessary.
Tenants will be included in the energy-saving measures through surveys and a specially designed online portal to check their consumption data.
In addition to innovations in building construction and building monitoring and control technology, a "low exergy approach" (LowEx) is being applied to an entire residential district for the first time.
The implementation of the neighbourhood concept, which began in 2009, should be completed by 2015.

Activities

To test the low exergy approach, two residential buildings that were renovated to improve their energy performance between 2009 and 2010 and monitored, were selected. The two rows of buildings with 5 storeys and a gable roof were built in 1956 and each have 30 apartments with a floor space of 65.5 m^2. They were renovated to different construction standards, and assessed using measured values. This experience will be used to formulate recommendations for future refurbishments of this housing type.
All 16 non-renovated buildings and three partially renovated buildings in the district should be modernised by 2014. The various buildings were grouped into three types according to their renovation status. The thermal insulation standard of the renovation measures will be examined separately. The empirical values from the two research buildings mentioned above will be used.
The new district heating system will be supplied from the district heating system of Stadtwerke Karlsruhe. With a share of currently around 85% from combined heat and power generation, after the construction of a pipeline to a refinery was completed in 2010, around 40 % of the heat demand in the Karlsruhe district heating network can be supplied from waste heat. This proportion may be increased, by subsequent expansion projects. The connection of the district to the district heating network is done indirectly through a transfer station, so that the district's network can be used with lower temperatures (initial temperature max. 75°C, return temperature as low as possible) than the upstream primary network of the city public services. The pipeline to the transfer station was built in 2008. The network, including the power transfer station, is currently being expanded and should be completed by 2012.
Half of the total costs for the project were allocated by EnEff:Stadt (5,1 m €). Apart from additional funding programmes the Volkswohnung GmbH will finance the realisation of the sustainability district concept which is set to be implemented until 2015 by affording 35–40m € additional financial means.

Results

The district energy concept for the Rintheimer Feld has been completed and data for an evaluation of the project has been available since late 2009. The energy monitoring and technical measurements started in spring 2010.
The feasibility study for the two demonstration buildings has been completed. The first of the two study buildings has already been renovated and in 2010 the tenants moved back in. The detailed planning documents for the second building have been completed and construction work has started.
Since the heat demand after project completion depends on the scope and type of energy efficient renovation of the buildings and this can only be determined once the project has begun, at the moment, only plausible estimations can be made for the project's impact on heat demand. It is estimated that the heat demand for heating and hot water will amount to 6,200 MWh per year after completion of the project in 2015. A precondition is that all remaining buildings belonging to Volkswohnung GmbH would be renovated according to an average standard of 75 kWh/m^2 by this date.
The specific primary energy use and CO_2 emissions to meet heating needs will be reduced by about 84%

according to current plans and compared to the beginning of the renovation measures according to EnEff:Stadt.

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3.25
Project: Renovation, renewable energy and electric mobility in Dresden/Gorbitz

● Supply ● Refurbishment ● User level ● Network ● Integrated concept

Image 50: Thermally insulated residential building Hetzdorfer Straße 18–24 © EWG Dresden

Location:	**Dresden**
Period of construction:	**1981–1989**
Settlement character:	**Residential**
Project status:	
Implemented by:	**Eisenbahner Wohnungsbaugenossenschaft (EWG)**
Programme:	

General information

The large housing estate Dresden Gorbitz is the youngest and largest housing estate in Dresden. Between 1981 and 1989, 14,000 apartments were constructed (now 12,018) using typical Soviet-style designs for large residential blocks. 5,740 apartments are owned by the Eisenbahner Wohnungsbaugenossenschaft (railroad worker housing association (EWG)).

The EWG created a concept for the area and submitted it to a nationwide competition for the energy-efficient renovation of large housing estates and it won a gold medal alongside four other participants.

Aim of the Project

The aim of the concept created by the EGW is to renovate around 1,000 apartments in combination with the implementation of pilot projects to generate electricity from renewable energy sources and electromobility.

The energy demand of the buildings after the renovation should exceed the requirements of the German Energy Saving Regulation (Energieeinsparverordnung, EnEV) for new builds. According to this regulation, up to 50 % of the energy costs could be saved.

Activities

In addition to installing very good insulation, optimizing thermal bridges and the improvement of air tightness, heat is supplied from district heating with combined heat and power.

The district heating supply is coupled with a CO_2 high-temperature heat pump that uses waste heat from the main sewer line.

“Energy roofs” connect an intelligent energy management system, small wind turbines and photovoltaic panels installed onto the building (include on the building façade) with an innovative storage system.

The renewable energy from wind, sun and waste heat will be directly available to the residents of the building to remove the need to feed the electricity into the interregional electricity grid.

The area was found to be suitable for the effective use of wind turbines following extensive wind measurements. The available wind comes up to 90 % from one direction. The wind speed distribution and strength resulted in a predicted energy yield of 3,500 kWh per wind turbine per year.

The electricity generated by wind energy should be enough to almost completely cover the necessary energy for powering the buildings’ equipment. Excess electricity is used in a mobility concept in electric cars and electric scooters or used for electric mobility.

A compact vehicle can, for example, have a realistic energy consumption of 20 kWh per 100 kilometres. This is equal to 17,500 kilometres per year for each wind turbine per year. The typical range of contemporary electric cars is 50-168 km and they are therefore adequate for commuting. Small scooters have an energy consumption of four to six kilowatt hours per 100 kilometres. Smaller electric bikes are already available in various different versions.

The energy consumption of the tenants will be shown visually in order to motivate them to save energy.

Results

A small wind turbine has already been put into operation in Gorbitz. On 14th June 2011 the EWG tested the system on the roof of an office building, including a test on noise pollution.

The wind turbine with 5 blades has a diameter of 2.5 m. The estimated yield of approximately 1,800 kWh of electricity per year is used to supply part of the basic energy requirements.

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3.26
Project: Upgrading of district heating by low-scale investments in Wernigerode

● Supply ● Refurbishment ● User level ● **Network** ● Integrated concept


Image 51: Socially deprived multi-storey buildings © Parabel Energiesysteme GmbH

Location:	**Wernigerode / Saxony-Anhalt**
Period of construction:	**1980–1985**
Settlement character:	**Residential**
Project status:	**Completed in 2010**
Implemented by:	**Gebäude- und Wohnungsbaugesellschaft Wernigerode mbH**
Programme:	**Urb.Energy**

General information
Late GDR-built residential buildings constructed between 1980 and 1985 were cost effectively upgraded in the realm of energy efficient heat supply. Comprising 29 blocks with a total living area of 61.700 m² the deprived accommodation units amount to 1.124.

Initial Energy Performance
The entire building ensemble in Wernigerode with altogether 29 buildings is completely provided with district heating, as it is deemed to be typical for GDR block buildings.170 kWh/m²a totals the entire heat energy demand of the ensemble.

Aim of the Project
Aim of the measures in Wernigerode was to adapt the existing heating distribution networks optimally to the actual needs, in order to reach significant energy cost savings and to impede unnecessary consumption at the same time. Besides it should be checked to what extent a stepwise implementation tends to be feasible and what savings can be eventually achieved by it. The project could act as a role model for the energetic and economical leverage even of lower-scale investment refurbishment.

Activities
The engineering company BBP Bauconsulting mbH has been contracted to plan and to implement the energy saving in 3 steps. The first one was a detailed consumption analysis and analysis of energy saving potentials on the basis of available consumption data and a stock recording of the heating stations, the distribution net and the radiators. Secondly they were assigned to render a calculation of new connected loads and to implement upgrades of heating controls. In the third place BBP supplied an optimization of hydraulics by hydraulic balance.

Results
During first and second step 0.49 €/m² investments face 2.08 €/m² savings per year, whereas investment step three entailed expenditures of 5.34 €/m² and 0.99 €/m² per year.
The initial final energy consumption of ca. 9,309 MWh/a could be reduced to a final energy consumption of ca. 7,620 MWh/a, which means savings about 18 %.
In Conclusion the example of Wernigerode proves that even minor investment measures can lead to notable energy savings.

Sources
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4 Glossary

Cogeneration Heat & Power (CHP)
Cogeneration of Heat and Power (or Combined Heat and Power) is the use of a heat engine or a power station to simultaneously generate both electricity and useful heat. Besides of large-scale CHP power plants, nowadays micro CHP units for natural gas are available down to 5 kW_{el} electrcial power and 12 kW_{th} heat. This gives an opportunity for cogeneration in neighbourhood or small clusters in local heating systems.

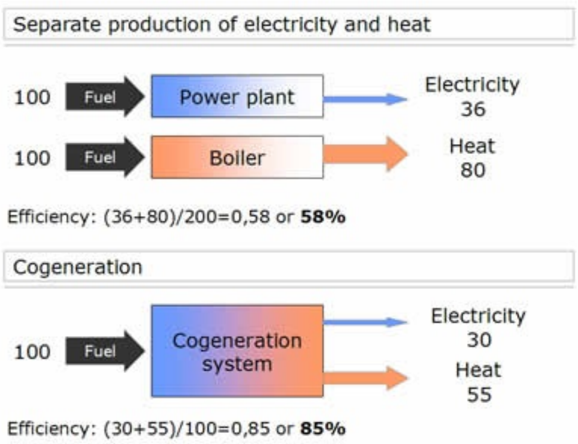

Diagram 10: CHP advantages (Source: Bioenergieberatung Bornim)

Energy Efficiency
contains the assessment of energetic quality and effectiveness in building stock by comparing energy demand parameters with referential levels of comparable buildings or by evaluating the energy consumption of an existing building in relation to comparable buildings.

Heat energy demand
is the necessary calculated heat demand for maintaining fixed thermal room conditions in accommodation units during heat periods.

Primary energy demand
describes the total amount of energy which is required for extraction, transition and distribution of fuels outside building-level, as well as the specific energy content of used fuels and the auxiliary energy for installation engineering.

Final energy demand
is the amount of energy the installation engineering gets provided with to ensure the determined interior room temperature, the heating of warm water and the requested illumination throughout the year.

Auxiliary energy
describes the energy amount used to transform the feeded-in energy by heat-, water-, ventilation- and lighting systems.

Renewable **Energy Sources (RES)**
Are naturally replenishing energy sources, such as sunlight, wind, rain, tides and geothermal heat. The share of renewable energy sources for the global final energy consumption amounts to 16%.

Smart Metering
Describes the use of two-way communication electrical meters on building level. Smart meters record the consumption of electric energy and deliver the information at least daily to the respective utility in order to lower energy consumption and energy costs.

District Heating
Provides space and water heating on district level from a centralized power plant for residential and commercial buildings. District Heating with Combined Heat and Power is the cheapest method to reach low carbon emissions

U-value
is the measure of the rate of heat loss through a material. Applied to buildings it describes the thermal conductivity of the external walls. Generally speaking the U-value should be as low as possible to impede unnecessary heat losses.

IUDC

Integrated Urban Development Concept (IUDCs) approaches combine the various sectoral planning concepts usually made for a city or neighbourhood and aims to achieve sustainable improvement of all relevant aspects of territorial use in a specific area. The underlying idea is to avoid misleading planning and instead to achieve synergy effects by dealing with all topics and sectors in one planning process. This target is achieved by combining not only physical investments in buildings and infrastructure, but also measures to promote economic development and social inclusion.

Sustainable Energy Action Plan
Sustainable Energy Action Plans (SEAP) use the results of the Baseline Emission Inventory to identify the best fields of action and opportunities for reaching the local authority's CO_2 reduction target. It defines concrete reduction measures, together with time frames and assigned responsibilities, which translate the long-term strategy into action.

Heat Pumps
A heat pump is a dual system that provides energy efficient heating in the winter months and energy efficient air conditioning in the summer months. A heat pump differs from a gas, oil, or electric furnace by transferring heat instead of producing heat. A heat pump can generate up to 4 times more energy than it consumes by moving heat instead of generating heat. Beside air source heat pumps there exist dual fuel/hybrid and geothermal heat pumps.

5 Appendix

List of Images

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Literature List

The manual was prepared on the basis of contributions from the different project partners of the respective partner countries.

German Association for Housing, Urban and Spatial Development (DV) e. V., Germany

- Compendium on National Framework Conditions for Energy Efficient and Integrated Urban Development Planning – Part 1, elaborated by B.&S.U. Beratungs- und Servicegesellschaft Umwelt mbH

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Gmina Piaseczno, Poland

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- Concepts for EER for Target Area in Grodno – Republican Programs of Energy EfficiencyIntroduction

List of Abbreviations

BEEN	Baltic Energy Efficiency Network
BSR	Baltic Sea Region
CEE	Central and Eastern Europe
CHP	Cogeneration Heat & Power
EC	European Commission
EE	Energy Efficiency
EEC	Energy Efficiency Commitment
EEG	Erneuerbare-Energien-Gesetz (Renewable Energy Sources Act)
EER	Energy Efficient Refurbishment
EnEv	Energie-Einsparverordnung (German Energy Saving Ordinance)
ENP	European Neighbourhood Policy
ERDF	European Regional Development Fund
IUD	Integrated Urban Development
IUDC	Integrated Urban Development Concept
JESSICA	Joint European Support for Sustainable Investments in City Areas
KfW	Kreditanstalt für Wiederaufbau (KfW Banking Group)
LBN	Latvian Building Code
MA´s	Managing Authorities
OP	Operational Programme
PP’s	Project Partners
RES	Renewable Energy Sources
TA	Target Area
WP	Work Package