POLYCITY Technique

Energy concepts in the POLYCITY project Scharnhauser Park

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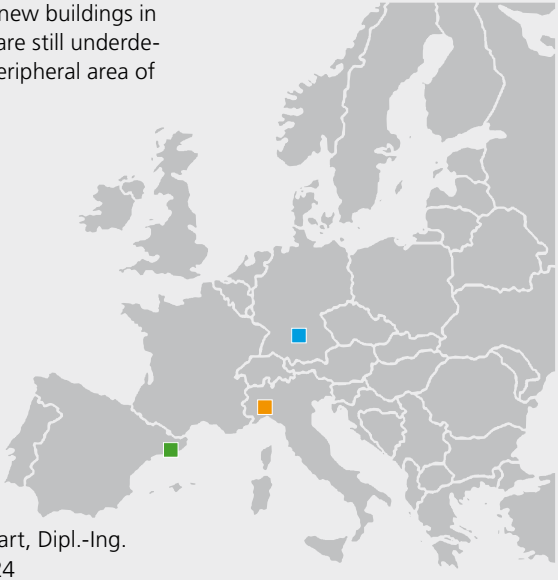
The POLYCITY project

The objective of the urban development project supported by the EU-programme Concerto is to reduce the consumption of fossil fuel through energy-efficient buildings and the increased use of renewable energies. The scientific research conducted within the framework of the project focuses on innovative energy saving technologies. In that respect, they employ simulation processes for the online optimization of the production of renewable energies on one hand and for the sustainable operation of the buildings on the other hand. The project respectively supports different aspects of urban development in three European cities: new buildings in locations which are still underdeveloped in the peripheral area of Barcelona, the renewal of an old district in Turin, and a mixture of redevelopment and new building in Scharnhauser Park, a former military area close to Stuttgart. Each project is incorporated in a network of regional partners and further observer communities, which ensure an effective exploitation of the achieved results. Having completed the first half of the five-year project, we would like to present this leaflet to you which describes the preliminary results of the technical aspects thus far handled . For any further information, please contact the zafh.net, the coordination centre of POLYCITY.



POLYCITY projects are located in Germany, Italy and Spain

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Energy Supply in Scharnhauser Park

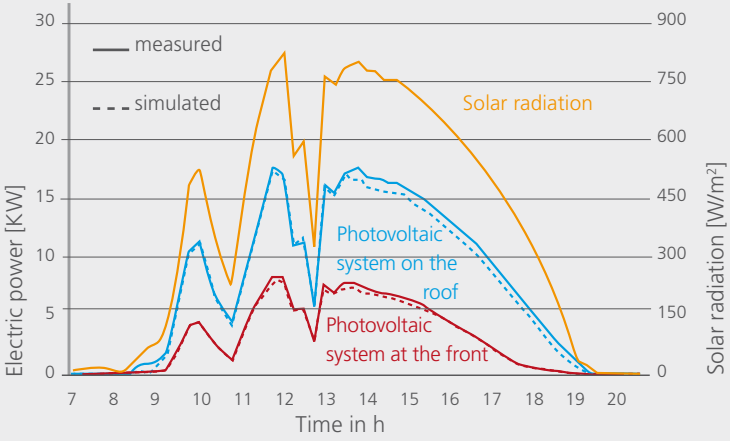
Solar power generation

Sunny times for Scharnhauser Park. Together with the partners Esslingen public services, the housing estate of Stuttgart and the city of Ostfildern, more than 37 kWp of new photo-voltaic equipment was installed in the course of the project. The most important unit is integrated in the building containing the combined wood heat and power plant, where both its south façade and the complete flat roof have been equipped with solar modules.

Solar modules on a flat roof in Scharnhauser Park

The equipment on the facade consists of dark monocrystalline modules and is not only an eye-catcher for pedestrians but, first and foremost, a highly efficient solar power station. This was recently confirmed by a study carried out by the research centre for sustainable energy technique zafh.net, in which the values measured at the stations can be compared online with simulated data. Both generators even produce somewhat more power than the simulation models generated from the data collected.

On the roof of the combined heat and power plant, a complete weather station has been installed, and its data is displayed minute-by-minute on the Internet. Operators of smaller solar stations in Scharnhauser Park can thus stay informed about the current radiation values and estimate the amount of power generated by their station.



Power diagram with simulated values and measured results

Biomass power plant

A wood chip power plant designed for 6 MW output in permanent operation, will provide the major portion of the energy supply for the Scharnhauser Park development project. At peak periods and as a reserve, two natural gas boilers (5 and 10 MW) are additionally available.

Each year, 80 % of the heating energy and approximately 50 % of the electrical power needed for an area where 10,000 people will soon live and work are produced by this plant.

Power production is enabled by a so-called Organic Rankine Cycle (ORC), a steam turbine process with organic working fluid, which can be operated without high pressures or temperatures and which can therefore be good combined with biomass firing. By this simple but refined concept, an economic and material-friendly process has been achieved compared to traditional water vapour power plants and is probably the most suitable type of plant for small- and medium-sized decentralized stations. The ORC can, by nature, adapt flexibly to the heating needs of the inhabitants with an almost constant high degree of efficiency. Considering the small dimensions of the station and the correspondingly low sound emissions, this plant concept can be particularly well integrated into the architecture of a district.

Great emphasis was placed on finding a system that was both reliable and had a low rate of emissions. Complex filter equipment and permanent emission monitoring provide pure air. The power station operators provide 24 h on-call service and guarantee a trouble-free supply for the inhabitants of Scharnhauser Park. With the POLYCITY project, improvements have been possible in the areas of data acquisition and power station regulation. The planned retrofit equipment for fume condensation can increase the thermal power output of the wood chip power station by around 1,000 kW and thus, can contribute to a corresponding saving of biogenous and fossil fuel energies.

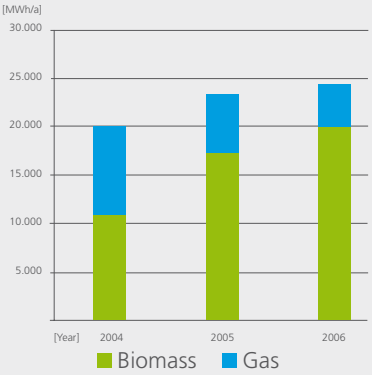
The combined woodchip heat and power station in Scharnhauser Park

Year	Heat quantity	Biomass
2004	19,899 MWh/Year	54.3 %
2005	23,306 MWh/Year	73.9 %
2006	24,255 MWh/Year	81.3 %

Produced heat quantity and part of biomass used for the energy generation heat quantity and part of biomass used for the energy generation

Local heating network

The US-Army, which used the Scharnhauser Park as a military base until 1992, already acknowledged the advantages of a central heating installation in conjunction with a local heating network to supply heating energy to the barracks. Through substantial modernizations and extensions, the local heating network now spreads over a length of more than 13 km and enables all the inhabitants of the Scharnhauser Park to use this environment-friendly technology.



Part of the consumed biomass proportionally to gas

The heating network in Scharnhauser Park

The POLYCITY project supports additional hot water accumulators in individual houses, which thus help buffer peak demands and in this way, helps reduce the volume of natural gas used in the peak load boiler.

A new technology for the increased use of heat in summer was examined in a new office building, in which an absorption refrigeration plant used heat from the heating network to produce cooling energy.

Thermic cooling systems

The improvement of the working load of the combined wood heat and power plant in summer by thermal cooling production was one avowed objective of the POLYCITY project. As the first plant of its kind in Europe, a lithium-bromide refrigerating machine has been now installed in the construction of a new office building in Scharnhauser Park. This machine is powered by the heat generated by the combined woodchip heat and power plant and is thus entirely produced from biomass. The plant will possess a cooling capacity of 150 kW and will be connected to a modern system for concrete core activation.

Due to the relatively high maximum cold water temperatures (9° C and 15° C), this system enables the realization of a high degree of efficiency for the refrigerating machine.

Development of the Scharnhauser Park project

Residential houses

Based on the plan suggested by the office Jansen and Wolfrum in 1992, the Scharnhauser Park in its current form emanates from a comprehensive urban development competition. The park can be divided into three different areas: in the northern district, the generally renovated American residential houses have been re-consolidated by the addition of tower houses. In the district located at the eastern part of the road, one can find a compact area with individual houses as row house development, while in the bigger Western part, four-storey multi-family houses with extensive green areas have been established along the character-giving landscaped stairs.

Residential houses in Scharnhauser Park

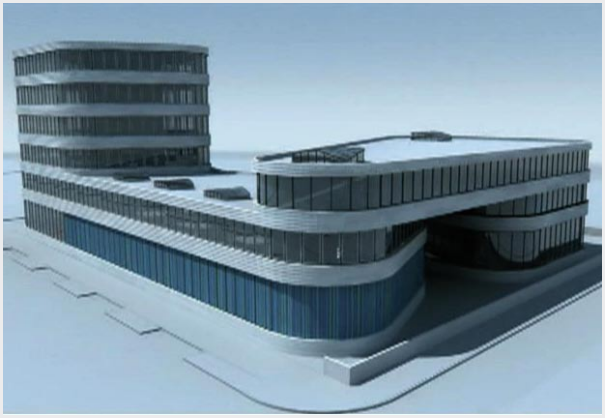
From an energy point of view, the heat supply, based mainly on biomass for all residential houses, is particularly exemplary. For this, all buildings were required to connect to the partially already existing long-distance heating network, which leads to extremely low CO_2 emissions as a result. Further, as prescribed in the development plan, the high-tech insulation coverings for all buildings had to be built according to a low-energy standard. In 1995, with a level of 25 % less than the maximum values allowed then by from the heat insulation ordinance, an unusually good standard for the middle of the 90s was created for all buildings, from which the building users of the Scharnhauser Park still benefit.
In order to achieve good overall neighbourhood energy efficiency figures, proprietary apartments and houses have also been built according to the low-energy building method, so that the consumption levels specified in the current energy saving regulation (EnEV 2002) are undercut by around 20 %. This was reached through additional measures such as reinforced exterior wall insulation, windows with improved environmental values, low temperature heaters in the form of floor heating, living space ventilation and quality controls using Blower-Door-Tests.

Elektror in Scharnhauser Park

The company Elektror, located till now in Esslingen, is presently building a new office building with an affiliated Research and Development tract in the Scharnhauser Park area. The building under development will set innovative standards not only in terms of architecture.

The energy supply for the large building of about 4,500m² will be provided by the combined woodchip heat and power plant operated by the public services of Esslingen. For this project, all of the cooling necessary for office buildings will be strictly thermally produced using a lithium bromide refrigerating machine, as opposed to the electric cooling production which is still standard nowadays. The heat energy needed for this will be entirely produced with renewable energies in the woodchip heat and power station. Thus, seen from a primary energy point of view, cooling this building this was as opposed to the compression refrigerating machine variant, is much more ecological. In order to cool the office building even more efficiently, instead of using a strictly air-based method to distribute cooling, the basic load is conducted by activating the concrete inside the individual floors. by making use of the concrete floors' potential for storing thermal energy his measure makes it possible to use the refrigeration machine very efficiently and helps reduce the maximum output dimension of the power unit. In case of heating, this concrete core activation system is also used to cover the basic heat load requirements. Since the building for static reasons had to be built using concrete piles anyway, these concrete piles were designed as so-called energy stakes. Like in the case of earth sensors, water tubes have been installed inside the stakes. These tubes deliver the heat to the soil in summer and take heat from the soil in winter. The extra costs for these energy stakes are small compared to the expected additional cooling power of around 30 kW. The amount of energy won by the energy stakes is integrated into the existing ventilation system of the building. In this way, the outer air to be introduced into the building can be neutrally (in terms of primary energy) pre-cooled in summer and pre-heated in winter.

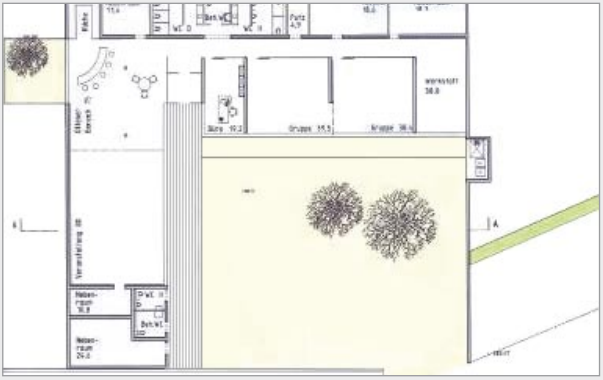
The new Elektror building will set innovative standards not only in terms of architecture



As part of the POLYCITY project in order to optimize the regulation of the building-technology components, all the data generated during operation will be be recorded, collected and evaluated.

Youth centre in Ostfildern

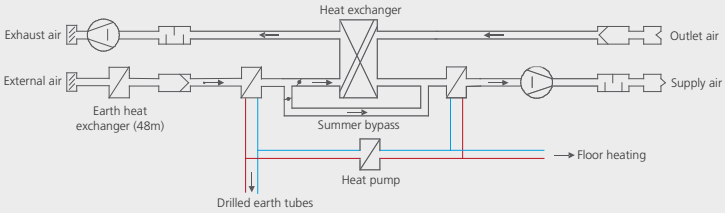
Likewise, the new youth centre in Ostfildern is also in the building stage. It has been built on the fringes of the Scharnhauser Park next to the sports facilities. Since no connection to the combined wood heat and power plant exists in this area, an independent energy supply has been planned for this building. In order to also keep the proportion of renewable energy consumed as high as possible, during the planning phase, particular attention has been paid to the idea of keeping the heat lost through the exterior walls as low as possible. One variant has emerged as the most economical solution, whereby the opaque parts of the building covering are implemented according to comply with passive-building standards and the windows are designed to comply with low energy building standards. By doing this, a very low annual heating requirement of 32 kWh/m²a for a big building like this (410 m²) - can be maintained. The energy required for this kind of building is provided by geothermal heat probes and an associated heat pump. Moreover, the building also has a mechanical ventilation system with heat recovery capability and a geothermal heat exchanger. In a primary-energy neutral way, this air-earth heat exchanger will pre-heat the aspirated outer air in winter and will pre-cool it in summer. Distributing heat and cooling throughout the building will be achieved through a floor heating system to cover the basic load and will use the ventilation system to cover peak loads and for quick preheating phases.



Floor plan of the youth centre in Ostfildern

Sectional drawings of the building

This building is also metrological documented by the research centre zafh.net, in order to compare actual energy consumption figures with the predicted ones in order to find any existing potential for optimization by adjusting the regulation of the overall system.



The mechanical ventilation system with heat recovery and geothermal heat exchanger

Municipal energy management

It was possible to reduce power consumption in the city hall by 20 %

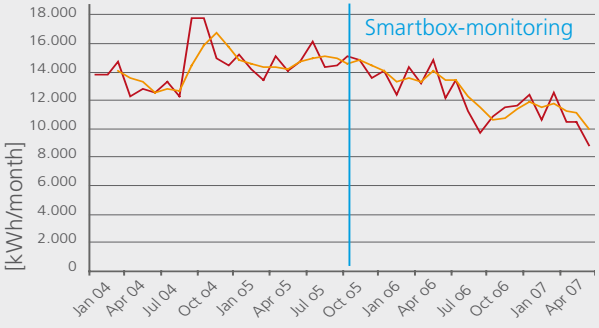
Beside using regenerative energies and constructing energy-efficient buildings, there is also much potential for reducing CO_2 – by reducing consumption in the existing buildings. In the Scharnhauser Park area, the local municipal buildings such as the city hall, primary and secondary schools with sports halls, a great number of kindergartens and day-care facilities for children, as well as the municipal building yard with its total gross floor area of around 21.000 m^2 , constitute a considerable portion of overall energy consumption.

In order to make the consumption levels more transparent, a kind of energy bookkeeping with at times detailed monitoring has been implemented. The rates of heat, power and, to a certain extent, water consumption in the most energy-intensive buildings are closely monitored, and these records are saved in the long term. Thus it becomes possible to reconstruct the success of energy-saving efforts which can be quickly passed on to maintenance personnel and consumers. For instance, a „Smartbox" from the company Ennovatis has been installed in the city hall as part of the framework of detailed monitoring. This gathers the rates measured in all the inner meters in a rhythm of every five minutes. Within 18 months, these few simple and inexpensive saving measures has already led to a reduction of more than 20 % compared to the former rate of power consumption, which was constantly increasing.

By using the Ennovatis controlling software, more and more municipal buildings are currently under energetic monitoring. In the future, an automated reporting system that includes warnings about unusual levels of energy consumption will be developed. That way the effects of the user's behaviour upon one's energy consumption can be optimally pointed out and can also be specifically directed as needed.

Over the whole city, municipal standards have been introduced, like the reduction of the EnEV standard for new buildings with -30 % under the legal requirements or the EnEV standard for new buildings emerging from the renovation of old buildings. In addition, the city council has specified a CO_2 environmental factor for financing new buildings of 50 €/t CO_2 over the lifetime of the building and also an annual budget for energy saving.

Power consumption of the city hall in Scharnhauser Park



– Power consumption (HT+NT)
– Flexible average (power consumption (HT+NT))

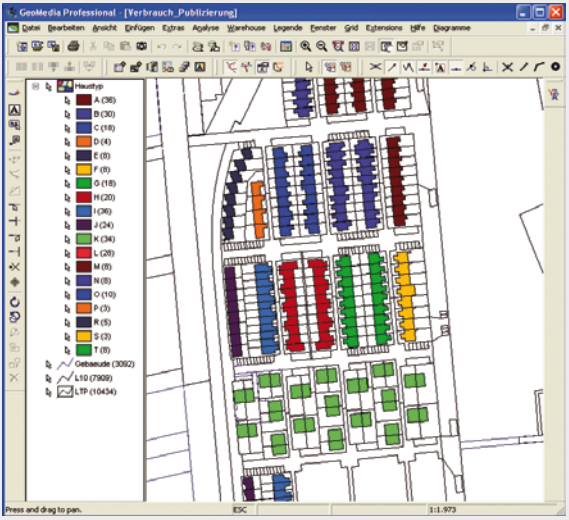
Geo-information system

For a professional visualization of all energy flows in the project area of Scharnhauser Park, a geo-information system has been established, with generates and displays descriptive information from thousands of consumption and production data. The development of the geo-information system is based on actual data from buildings that was recorded in a data base.

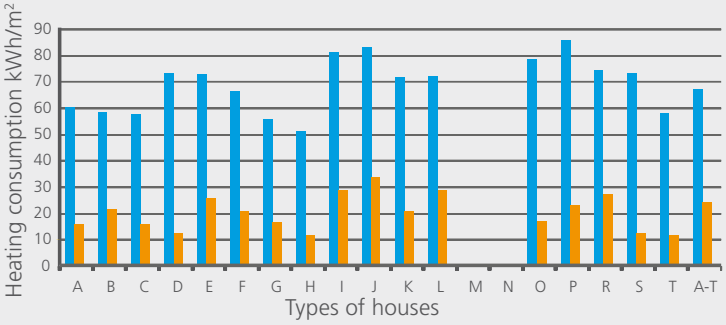
The building data covers both the characteristics of the buildings and the key data about the energy consumption levels for heating and power. The geo-information system offers the many different options for displaying this data as thematic maps or as bar charts. For data security reasons, heating and power data for row houses can only be visualized only as an average value for the respective type of house or in the case of residential houses, only for the respective building groups..

The geo-information system offers a good solution for managing the energy consumption of whole neighbourhoods and therefore allows an optimized use of the potential of renewable energies.

The system can also be used for the publication of data on the Intranet / Internet. In this way, residents of Scharnhauser Park can have constant access to the energy consumption data for their own houses and can thus control their current power and heating habits, which allows for more conscientious use of energy resources.



The geo-information system delivers key data about energy consumption



Row houses heating consumption 2006, average value for the relative type of house

Average
value of
the standard
variation

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www.polycity.net

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