«Take Five» - refurbishment of military barracks in Freiburg, Germany

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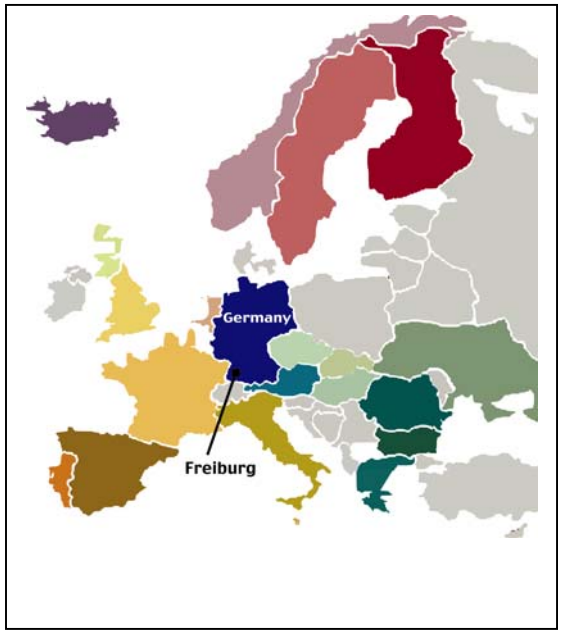
OVERVIEW

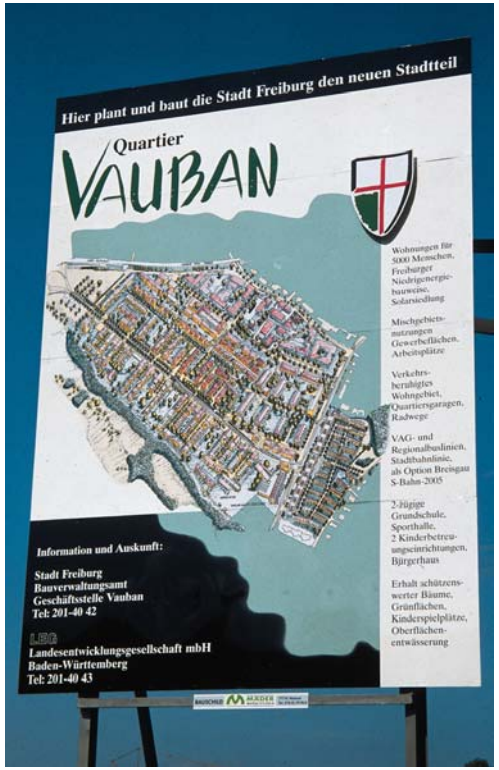


City of Freiburg with 200.000 inhabitants is located in the South-West corner of Germany. Freiburg is a main centre (university, little industry, mainly services). The city is surrounded by the Black Forest Slopes and opens to the plain of the Upper Rhine Valley.

a new district (42 ha) is being developed for 5,000 inhabitants and will be completed in 2006. The new district is called **"Quartier Vauban"** after a French army barrack site at the same location, that was abandoned in 1992.
The Quartier has 15 old military barrack buildings constructed between 1933 and 1958 which can be transferred into new use. Due its historic use as closed military areal, the district has a an autonome energy infrastructure and an old tree stock.
Embedded by the Black Forest slopes and very close to the City Centre the Quartier Vauban is the most attractive development area of Freiburg.

Quartier Vauban as military site of the French Army, photo from Forum Vauban.e.V.

The Site: Quartier Vauban



Quartier Vauban was turned into a development measure of the City of Freiburg which will be completed in 2006, Photo by Forum Vauban e.V.

As a result of the historic development of 1990 the City of Freiburg got property of the French Army barracks which had been closed to the German public for more than four decades. Consequently, there was a strong public focus on the development of this new space of 38 ha in the city centre. Quickly a consensus was reached between local decision makers and the public that this unique opportunity is to be used for creating truly innovative living and working structures. The idea of a “sustainable model city district” was born.

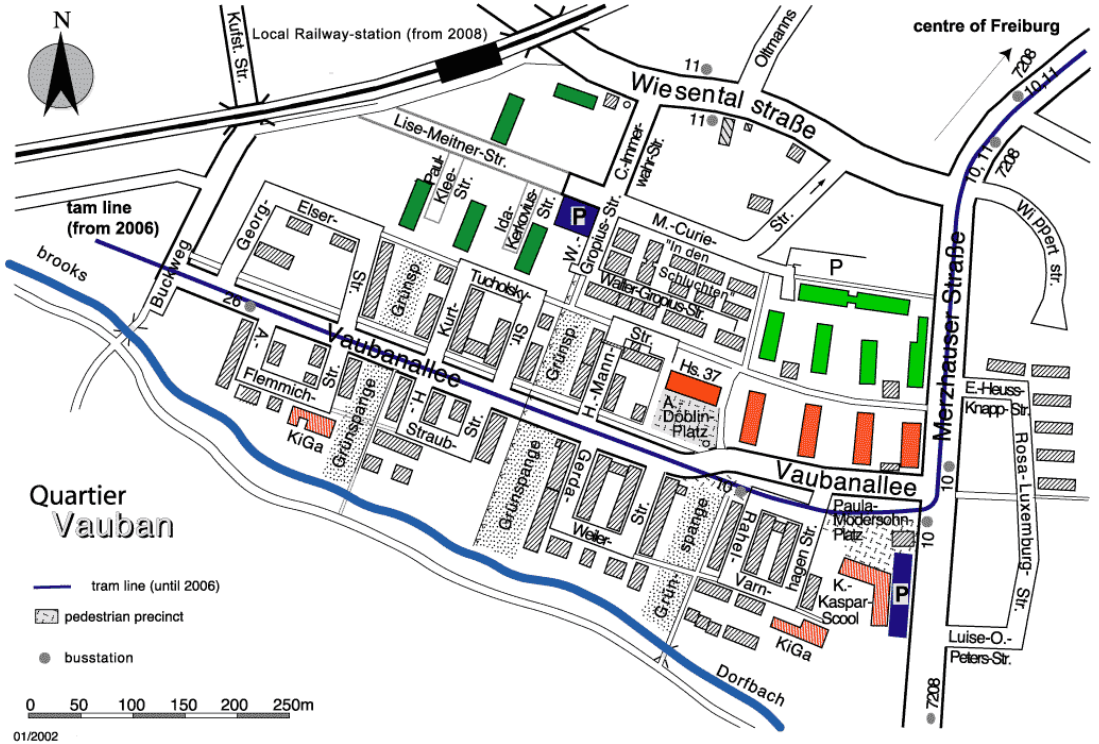
15 barrack buildings with more then 25.000 m² of space can be preserved. They can be transferred into cheap living space for students or low income families as well as for social projects and intiatives. Finally, cheap office space for innovative start – up companies, Photo by Forum Vauban e.V. First conversion projects have been implemented succesfully in Quartier Vauban between 1992 and 1996.

Project Idea

Building of the conversion project SUSI in Quartier Vauban, photo by Forum Vauban

First demonstration projects in Quartier Vauban have proven the feasibility of conversion projects. Between 1992 and 1996 the initiative SUSI has refurbished four barrack buildings and transfered the old buildings into living space for students and underprivileged people.

The Project „Take Five“ strives to transfer the five barrack buildings in the north-west corner of Quartier Vauban (below in dark green colour) into living space for various social and political purposes. Three buildings will be used as cheap living space providing 45 flats with 4.500 m².
The remaining two buildings ware predestined to house offices and other public and commercial entities. For these conversion purposes the main building structure will remain untouched what will allow a very cost efficient refurbishment.
By preserving the buildings the City of Freiburg will save the expenses for the demolishment of the building structure which will create expenses of more then 1.750.000 Euro.



Project Objectives

Vision of Sustainability

Project main objective is to implement a building refurbishment according to the vision of sustainability which combines social, economic and environmental benefits:

Social benefits

Social benefits
- Offering cheap living space to low income families
- Improving the indoor and outdoor living conditions
- Creating office and meeting space for important social and political intitiatives
- Saving the demolishment expenses for the City of Freiburg
- Barrier free renovation

Economic benefits

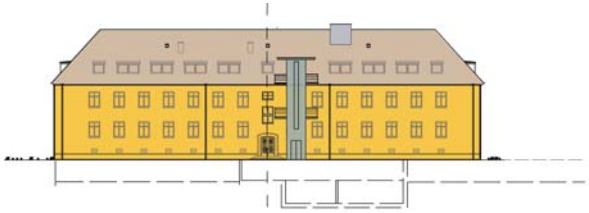
Economic benefits
- Creating cheap office space for innovative start-up companies
- Starting employment effects by the labour intense refurbishment process

Environmental benefits

Environmental benefits
- Optimally integrating high efficiency design for heating and electricity demand in the refurbishment action
- Striving for CO2 reduced heating supply
- Saving resources and CO2 by preserving the old building structure
- Providing high living quality while preserving most of the old building stock
- Using environmental construction material
- Innovative Demand Side Mangement System for computer based room heating
- PV Solar System invested and operated by the neighbourhood residents

Building Description

The buildings were erected after 195. All buildings were refurbished in the year 1992. New windows were installed in this refurbishment action. The last years the buildings were used as home for asylant seekers.



Elevators are planned for reaching the objective of a barrier free living

Every barrack building has a ground floor of 45 meters times 16 meters. The buildings have two storeys and a roof floor with attic windows.

To enhance the living space the refurbishment action will add to the buildings additional windows in the attic and external staircases.

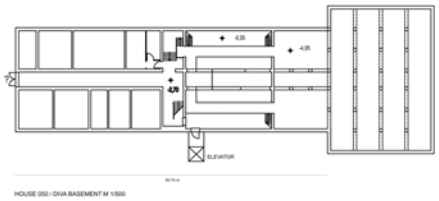
Building Description

The buildings have large corridors in every floor with regular room shapes on both side.. The transfer into offices is comparatively easy. The change into living space for families requires some infrastructural changes.

First Floor Structure

Attic Floor Structure

Ground Floor Structure



Basement Structure

Building Energy – Status Quo

The windows have been replaced in 1999

The roofs only show minimal insulation

Today the buildings show the following energy characteristics:

The buildings have outer walls with a thickness of 38 to 51 cm fabricated from bricks (clinker) with a U- Value of 1,5 W/m²K.
The roof is a tilted and covered with tiles supported by rafters. Minimal insulation is applied resulting in a U-Value of approx. 1,3 W/m²K.
The basement ceiling is made of concrete with little insulation and a U-value of 0,9 W/m²K
The windows have been exchanged in 1999 their U Value is 1,5 W/m²K.

Heating demand
The heating demand is about 164 kWh/m²a for the residential houses and about 156 kWh/m²a for the office buildings. (Assuming a reduction of heating temperature during night)

The average electricity demand for the residential buildings is around 27 kWh/ m² while the office buildings require about 50 kWh/m²a

The hot water demand for the residential buildings is approx. 31 kWh/m²a and about 8 kWh/m²a for the office buildings. (Assuming a central DHW production, including losses)

Heating Supply
The military district was provided with heat from a fossil fired gas district heating system.

Implementation

1. Microclimate

The photo shows the large trees which – if preserved – significantly improve the microclimate in summer time.
Photo by Forum Vauban.

In winter the comparatively moderate Freiburg climate does not require micrroclimate measures. In the hot summers however measures for stimulating ventilation and cooling should be taken.

A) **Vegetation:** The city district is blessed with a strong stock of summer green trees most of them growing in close proximity of the old barrack buildings. The conservation of the barracks is the optimal way to preserve this tree stock and significantly improve microclimate conditions in Quartier Vauban.

B) **Night ventilation:** The cool night wind falling down from the Black Forest Slopes on the Southern Side of Quartier Vauban has an important cooling effect in summer times. Thus, openings for this local ventilation must be preserved. For “Take Five” however which is situated in the far north west of the city district this local ventilation is of minor importance.

The local climate is very moderate: The sun shines more than 1800 h/a; with a global radiation of 1100 kWh/m² *a.
Average wind speed is 2,7 m/s (all year average).
The average temperature is 10,3 °C (all year average).

Implementation

2. Improved Opaque Building Envelope

„Take Five“ will implement the following measures for improving the building envelope:

Insulation:

- Outer walls insulated with 15 cm (mineral fibre) which will reach a U-Value of 0,23 W/m²K
- Basement ceiling insulated with 10 cm mineral fibre which will reach a U-Value of 0,28 W/m²*K.
- Roof insulated with 20 cm mineral fibre, hich will reach a U- Value of 0,23 W/m²*K.

Reduction of air leakage:

Air leakage shall be reduced to a minimum by most detailed planning and tight co-ordination of all planners and craftsmen.

3. Improved Glazing

The windows will be improved with of douple pane glazing reaching an U-Value of 1,4; g= 0,58 W/m²*K.

The enlargement of the attic windows will significantly enhance the solar gains of the barrack buildings.

With these measures, the energy demand for heating can be reduced to approx. 75 kWh/m²a for the residential buildings and to 65 kWh/m²a for the office buildings respectively.

Implementation

4. Renewable Energies

Previous demonstration projects have shown the feasibility of using the barrack roofs for PV Solar Systems which are erected by cooperative financing

The orientation of one building is optimal for solar gains, the others four buildings however have roofs east-west orientation. Nevertheless, also on these buildings the solar gains reach 80% of the maximum gains possible with an ideal oriented surface.

If one side of the roof is completely covered by PV Solar Systems the plant will reach a peak power of approx. 26 kWp and a gain of 18.500 kWh/a. The gains on the building with optimal orientation will be around 22.200 kWh/a.
With this amount 45% of the electricity demand of the residential houses and 24% of the demand of the office buildings can be covered.
The plants will realised by private investors preferably the building residents. These shared ownership structures have shown very good success in various renewable energy projects in Germany.

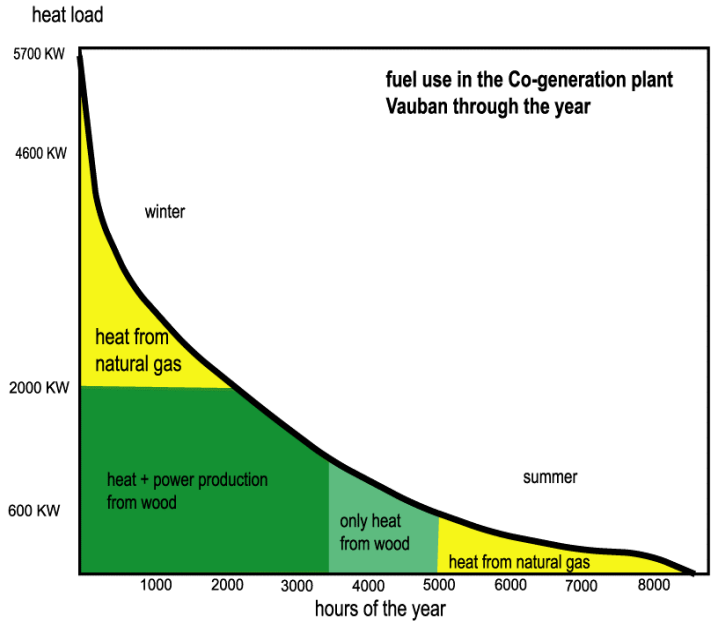
As the district heating system supplying the Quartier Vauban runs on natural gas during the summer season (see next page), solar thermal devices can contribute to the reduction of CO2 emissions.
Aiming at a solar fraction of 50 % in the hot water supply the plant size for the residential buidings will be about 60 m² and for the office buildings of about 16 m² (flat plate collectors).
Prerequisite for the installation of a solar thermal plant is a central DHW system.

Implementation

5. CO2 Reduced District Heating

The new wood chip based cogeneration plant of Quartier Vauban

The buildings will be connected to a district-heating network. The Quartier Vauban cogeneration plant is fuelled with wood chips most of the time, which is supported with natural gas in moments of peak demand in winter. In the summer months the reduced demand is covered with natural gas as well.
Over the year the use of the different fuels is as follows:
Wood chips: 16.800 MWh/a; natural gas: 3.600 MWh/a, oil: 440 MWh/a
The electricity production is about 1.000 MWh/a.
As the plant runs on natural gas during the base load during summer a solar thermal plant on every building is recommendable. Especially considering the relatively high losses of the distribution network in that period.



This graph shows the fuel mix in the Quartier Vauban co-generation plant.

Implementation

6. Demand Side Management

Special emphasis will be laid on an innovative heat control, which allows automatic heat control according to the specific user profiles in each single room. An innovative controlling device will induce individually to every thermostatic valve, if the user profile – according to a database in the Internet – demands for heating at the given moment.

Simulations have shown that in commercial buildings this measure can reduce the heating demand to the same degree as an outer insulation of 10 cm.

Additionally, low energy household appliances will be promoted. The planners have been commissioned to individually advice and instruct the future users.

Joint washing and drying devices will be provided to increase the efficiency, and all dish-washers will be connected to hot water supply.

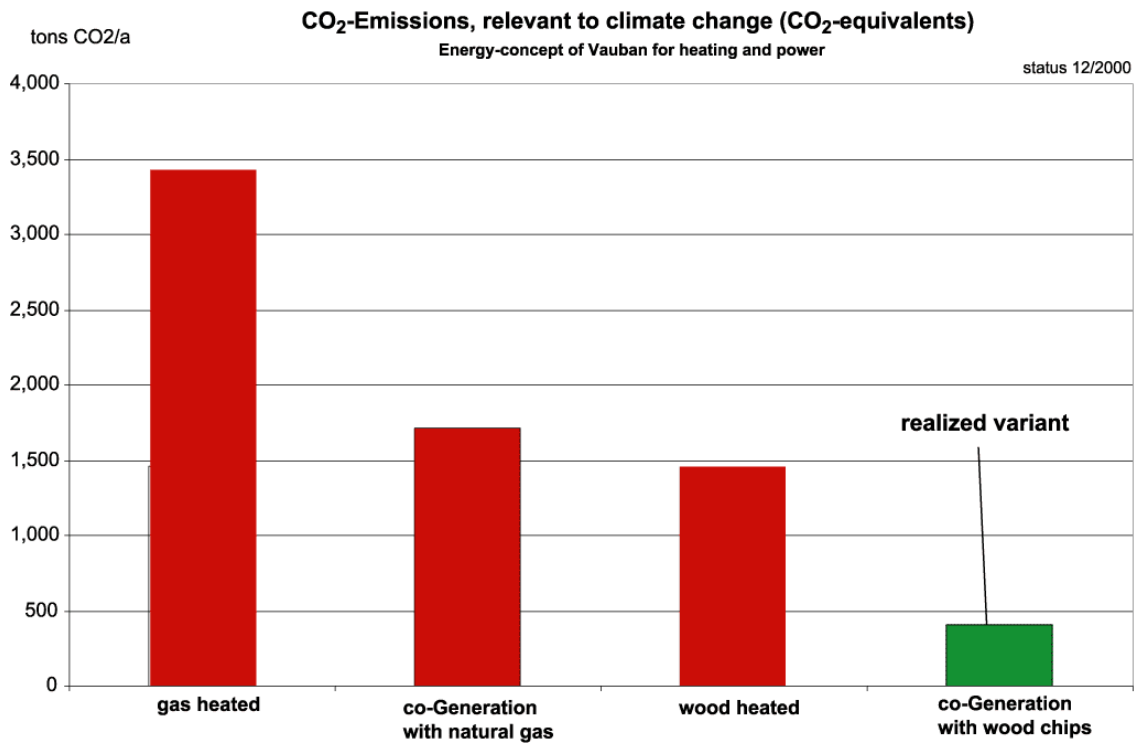
Natural gas will be provided in every kitchen for cooking.

7. Controlled Ventilation with heat recovery

A ventilation system with heat recovery can reduce the ventilation losses of the buildings by approx. 80% (22 kWh/m²a).
From a practical point of view the installation of such systems in the buildings is quite difficult as the required space for the ducts and central machines as wells as the investment cost is relatively high (40 – 60 €/m² of floor area). For this reason controlled ventilation is not considered for the refurbishment.

Evaluation Energy Supply

Different Options for District Heating in Quartier Vauban.



The survey shows the CO2 effects of different heating supply options for Quartier Vauban. It becomes obvious that fossil based cogeneration has a similar level of CO2 emissions as biomass based heating supply. The combination of cogeneration and biomass fuels however brings a significant improvement in CO2 emissions.

Global evaluation

	Depreciation Time	Additional Cost	Energy Savings	CB Ratio
Scenario 1: Improved Insulation				
Residential Buildings	30	272.000	392.000	0,02
Office Buildings	30	182.000	256.000	0,02
Scenario 2: Improved Glazing				
Residential Buildings	25	351.000	2.400	5,90
Office Buildings	25	234.000	1.607	5,80
Scenario 3: Solar Thermal Device				
Residential Buildings	25	124.642	65.882	0,08
Office Buildings	25	25.106	11.612	0,09
Scenario 4: PV Solar Systems				
Residential Buildings	25	462.400	55.488	0,12
Office Buildings	25	308.267	36.992	0,12
All Scenarios				
Residential Buildings		1.210.042	515.770	1,77
Office Buildings		749.373	306.211	1,87

The Global Evaluation shows that the opaqe building insulation is highly feasible. Also the thermal devices are highly recommendable for the residential buildings. The PV Solar Systems do not have a strong economical feasibility what however should be accepted in sight of the very large CO2 emission reduction potential. Electricity is weighted with a factor of 2,85 The exchange of the relatively new windows is having a very negative economic effect. The new glazing however not only reduces the energy demand but also significantly enhances the living quality.