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German experiences in energy-efficient revitalisation of urban areas

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insar PartG

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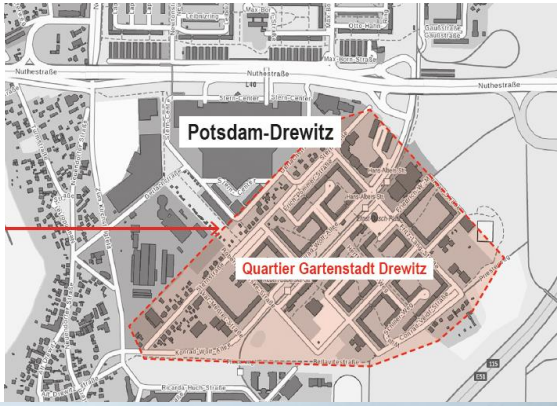
Gartenstadt Drewitz

Potsdam

Integrated energy-efficient neighbourhood refurbishment of a large housing estate

Hard facts

Location:	South-eastern outskirts
Size of the area:	Approx. 40 ha
Typology and age:	5-storey building in panelled construction from the 1970s
Utilisation structure:	Residential, commercial and social facilities
Number of residents / units:	6,000 inhabitants, approx. 3,000 residential units
Ownership structure:	Predominantly municipal housing company ProPotsdam GmbH



Initial situation and objectives

Socially weak

Unrefurbished buildings

Oversized traffic areas

The aim is the energy and climate-friendly urban regeneration of Drewitz with a particular focus on social compatibility. Through a mix of measures, Drewitz is to be developed into a zero-emission neighbourhood by 2050, as the first district of Potsdam.

Refurbishment Process

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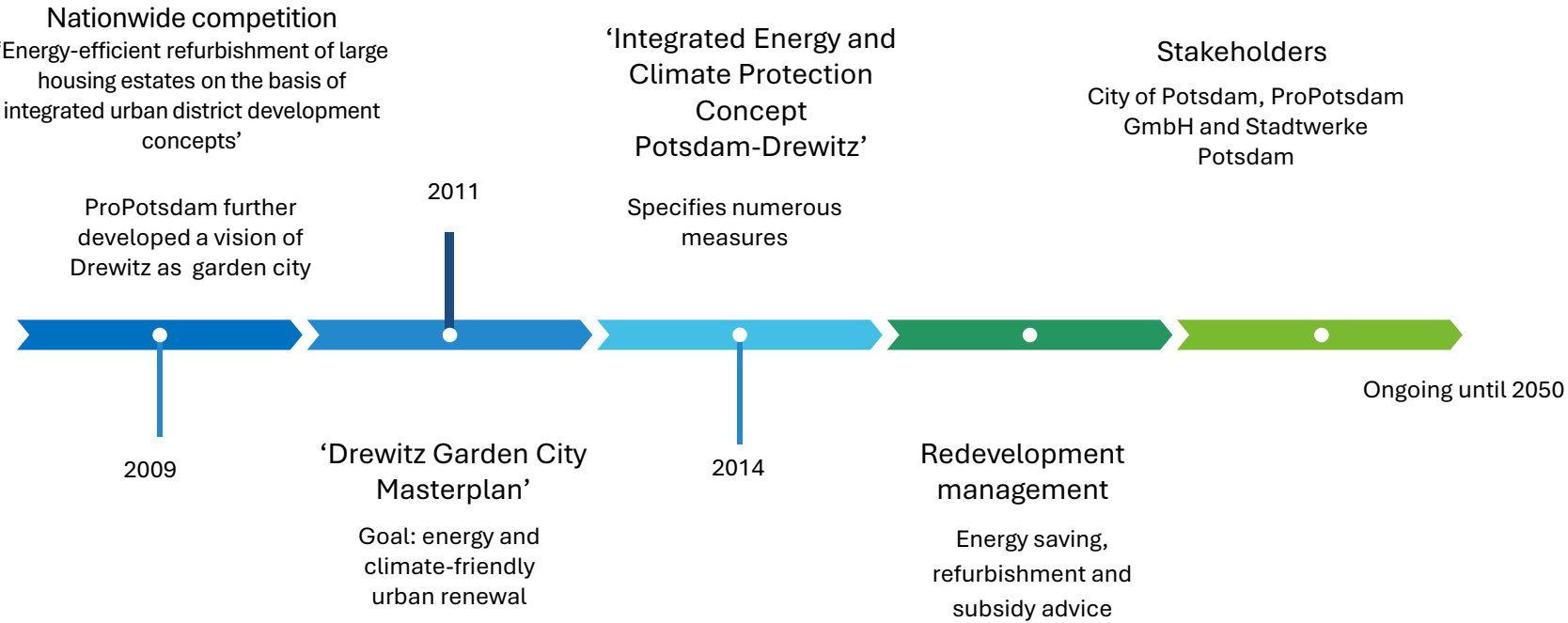

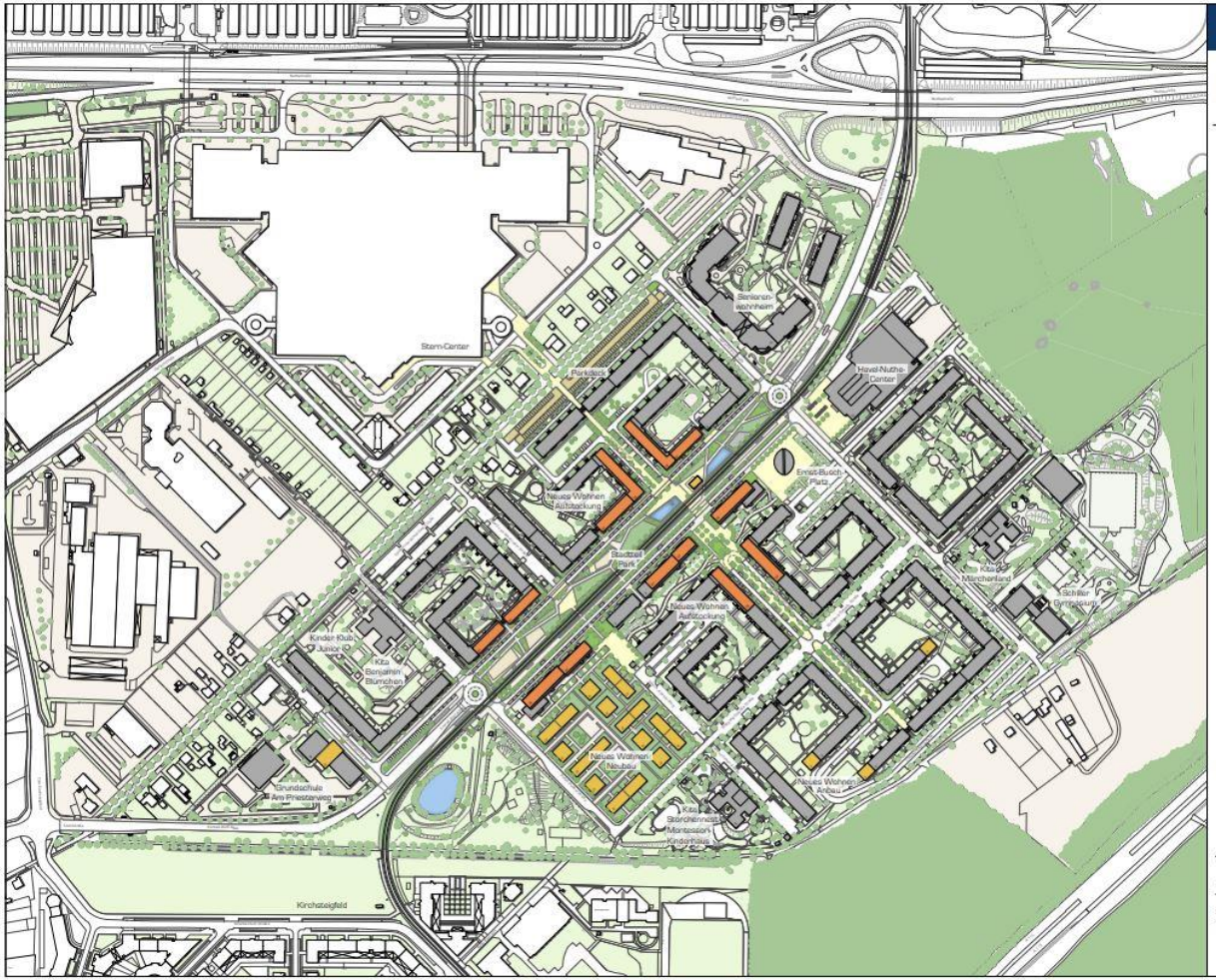

Landeshauptstadt Potsdam

Gartenstadt Drewitz

Fortschreibung Städtebauliches Konzept und Werkstattverfahren

unter Berücksichtigung der Konzepte zur Verkehrsplanung und zur Freiraumgestaltung von:

M 1 : 1.500

MASTERPLAN

November 2011

bearbeitet von:

STADT • LAND • FLUSS
Büro für Städtebau und Stadtplanung

ts | pk
thies schröder
planungskommunikation

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Measures taken

Energy-efficient refurbishment

of the buildings to KfW Energy Efficiency House Standard 70, including insulation, renewable energy supply, lifts and balconies. The building refurbishment reduces the energy demand in the district, which can be largely covered by ‘green district heating’ and ‘green electricity’ in future.

Conversion of Konrad-Wolf-Allee

The transformation of the oversized, central traffic axis Konrad-Wolf-Allee into a neighbourhood park was an important project. The newly created Konrad-Wolf-Park offers a green, traffic-calmed development over a length of 450 meters. The tram line was integrated into the side of the park. The new neighbourhood park offers leisure and exercise facilities for all generations.

District school

The concept of the district school is an innovative combination of school building and meeting place. The aim is to create a public space that is not only open to pupils, but for neighbourhood-related activities in the fields of social, cultural, educational, training and leisure.

Conclusion

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Financing

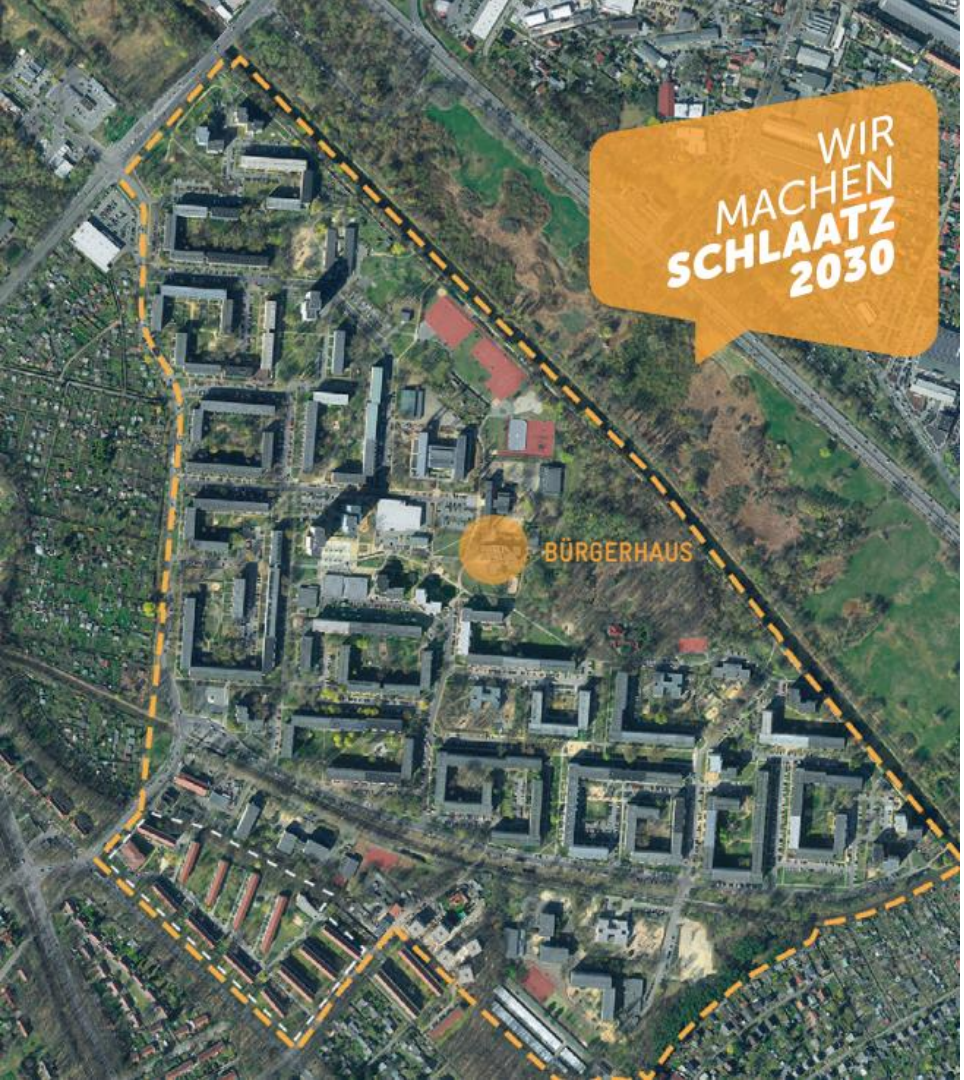
Investment volume	300 Mio. € (2017)
Sources	Own funds and subsidies
Funding	• KfW-funding for concept and redevelopment management • Urban development support ('Socially Integrative City') for public space and participation • ERDF-funding from the EU for the remodelling of Konrad-Wolf-Alle • Social housing funding from the federal state of Brandenburg for intergenerational building modernization • EDF funding for the expansion of district heating and electricity supply

Result

Many measures have already been implemented or are in the process of being implemented (e.g. neighbourhood centre, green public spaces, renovation). Thanks to subsidies, tenants benefit from a modernized flats with affordable rent.

Learnings

The pilot project 'Gartenstadt Drewitz' shows that high standards for climate-friendly and energy-efficient transformation and the social compatibility of the measures are not contradictory. The integrated, participatory and cooperative approach forms the basis for this, as it gives access to different funding pots. The project has received several awards.



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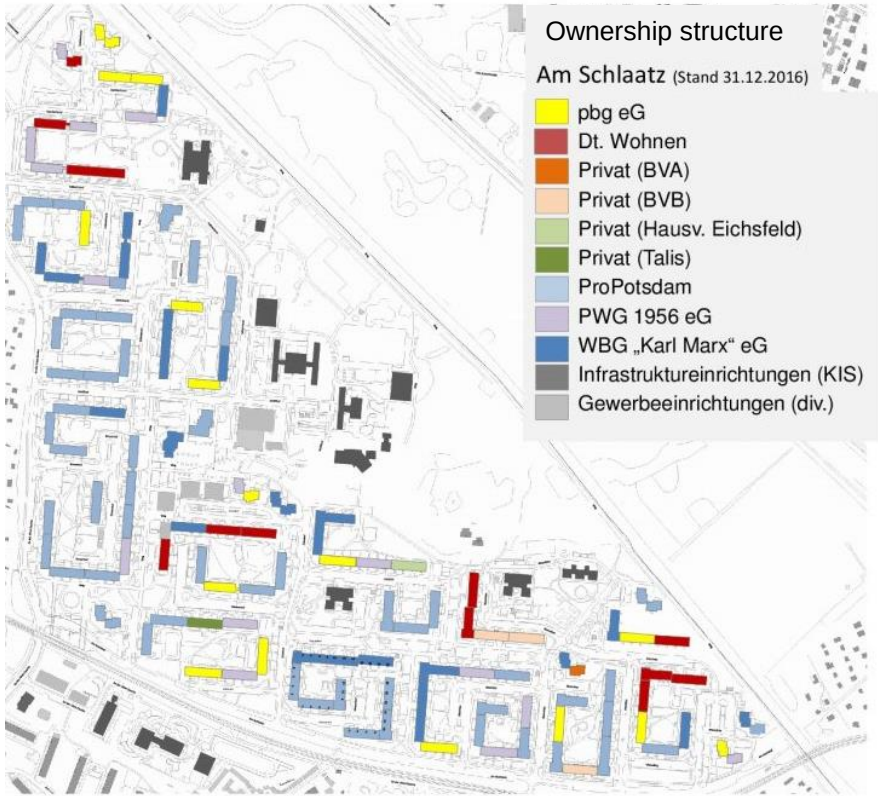
“Wir machen Schlaatz 2023”

Potsdam

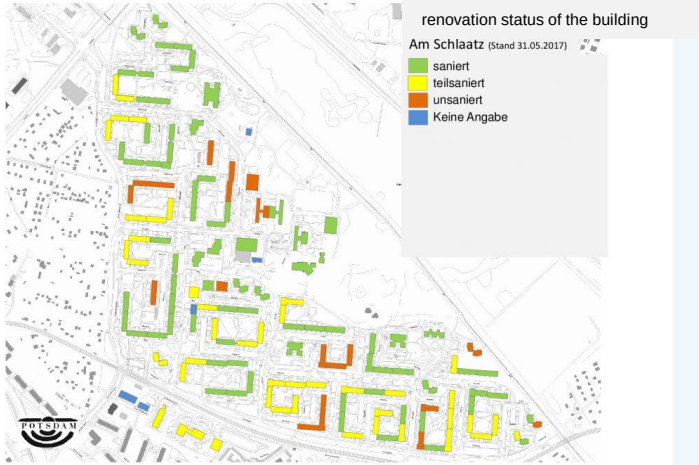
Refurbishment of a large housing estate with a major participation process and cooperation between the housing associations

Hard facts

Location:	Southern outskirts
Size of the area:	-
Typology and age:	Large housing estate from the 1980s. Structured along two central axes. Lower infrastructure and commercial units in the north-west of the neighbourhood.
Utilisation structure:	Residential, commercial and social infrastructure
Number of residents / units:	Approx. 9,400 residents
Ownership structure:	Housing associations (especially ProPotsdam), co-operatives, municipality and various others



Initial situation and objectives



Young and low-income neighbourhood with particularly high development needs and renovation backlog

Schlaatz is currently the largest remodelling project in the city of Potsdam. The aim is to develop it into a sustainable neighbourhood.

Refurbishment Process

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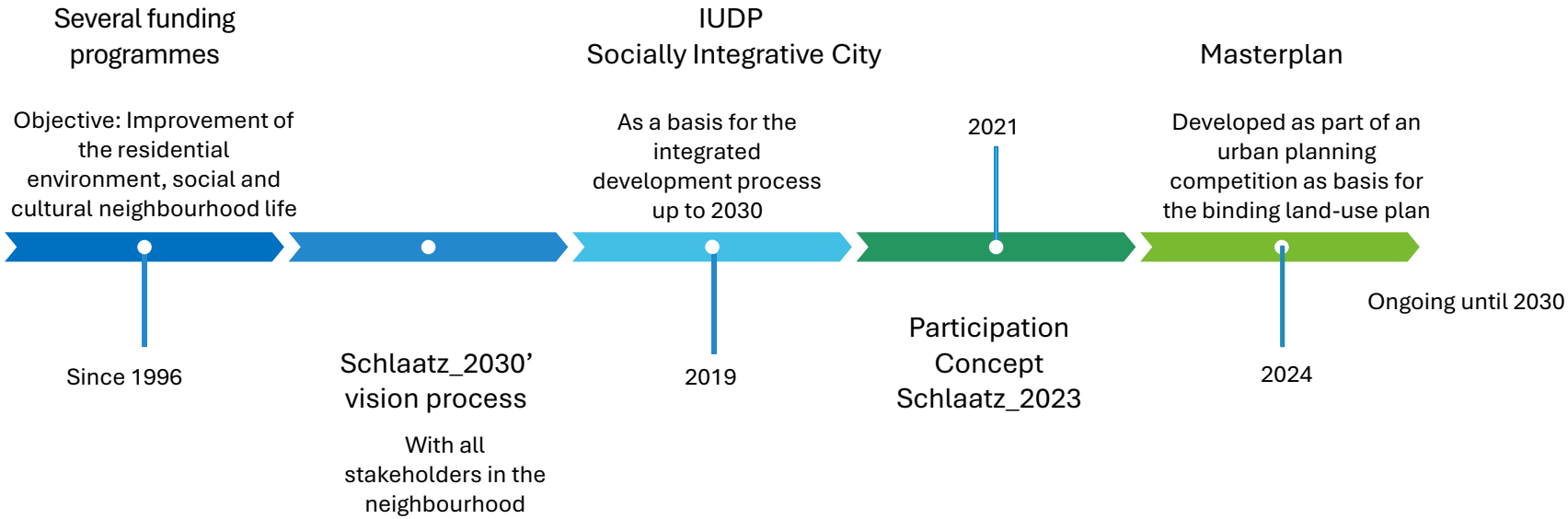

Refurbishment Process

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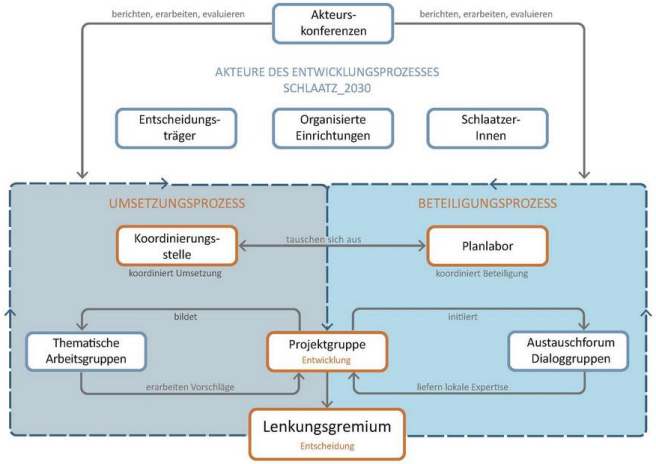
2030



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Measures taken

Governace

‘Bündnis Am Schlaatz’, an alliance between the municipality and the social oriantated housing companies and organisations with building stock (together approx. 85%) in the district that has existed since 2019.

Stakeholder conference since 2018 as a cooperative format: over 60 stakeholders from associations, organisations and institutions in the district, politicians, housing companies, administration and residents work together in the conferences.

Schlaatz Council = active representation of residents' interests (consisting of 16 members) constituted since March 2024, is part of all decision-making bodies of the urban development project ’Schlaatz 2023’.

Planlabor

Information container at the market with the presence of neighbourhood management or the Planlabor (was formed in 2022 for participation in the master plan process).

Conclusion

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Financing

Investment volume	Unknown (ProPotsdam plans with € 195 million between 2020 and 2033)
Sources	Own funds and subsidies
Funding	Urban development support from the ‘Social cohesion’ programme

Result

The process is still in its infancy. The binding land-use plan and a mobility concept are currently being drawn up. Independently of this, individual building renovations and the redesign of the central access axis have already been completed.

Learnings

The future will tell...

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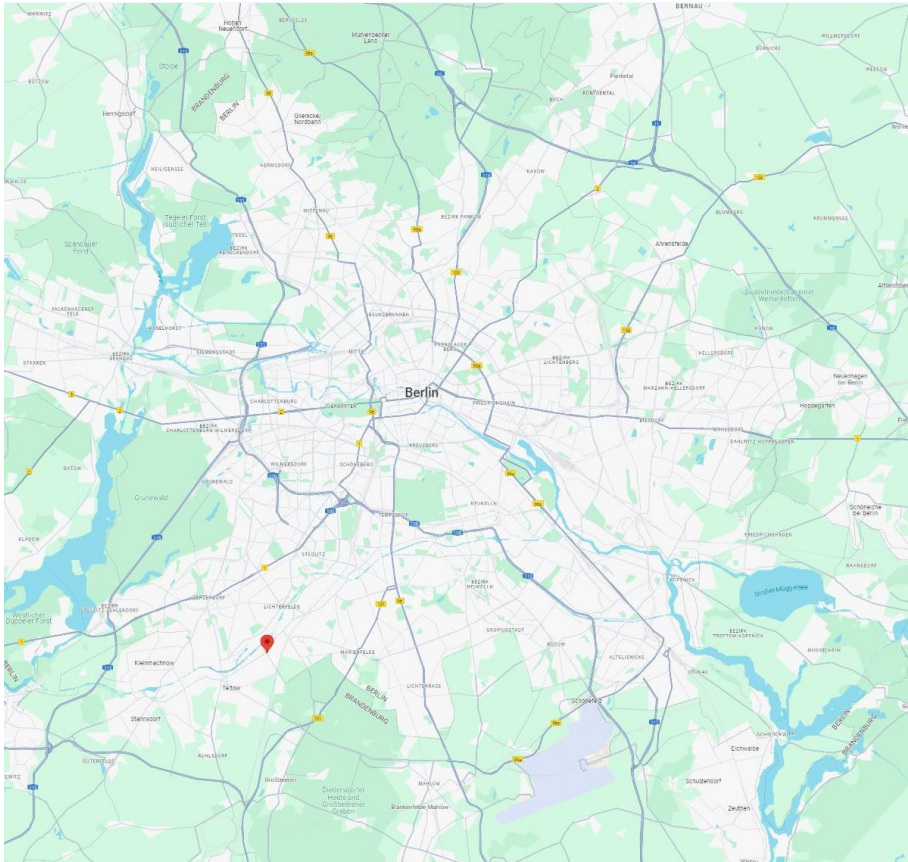
Märkische Scholle

Berlin

Co-operative residential district with socially responsible refurbishment and new construction

Hard facts

Location:	South-western city boundary
Size of the area:	-
Typology and age:	Multi-storey open residential development from the 1930s and 1960s
Utilisation structure:	Residential
Number of residents / units:	842 residential units
Ownership structure:	Berlin housing co-operative Märkische Scholle



Initial situation and objectives

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Unrenovated building stock resulted in high maintenance and energy costs

Renewal of energy generation and energy-efficient refurbishment of the buildings

Creation of age-appropriate and family-friendly living through addition of storys and new construction

Refurbishment Process

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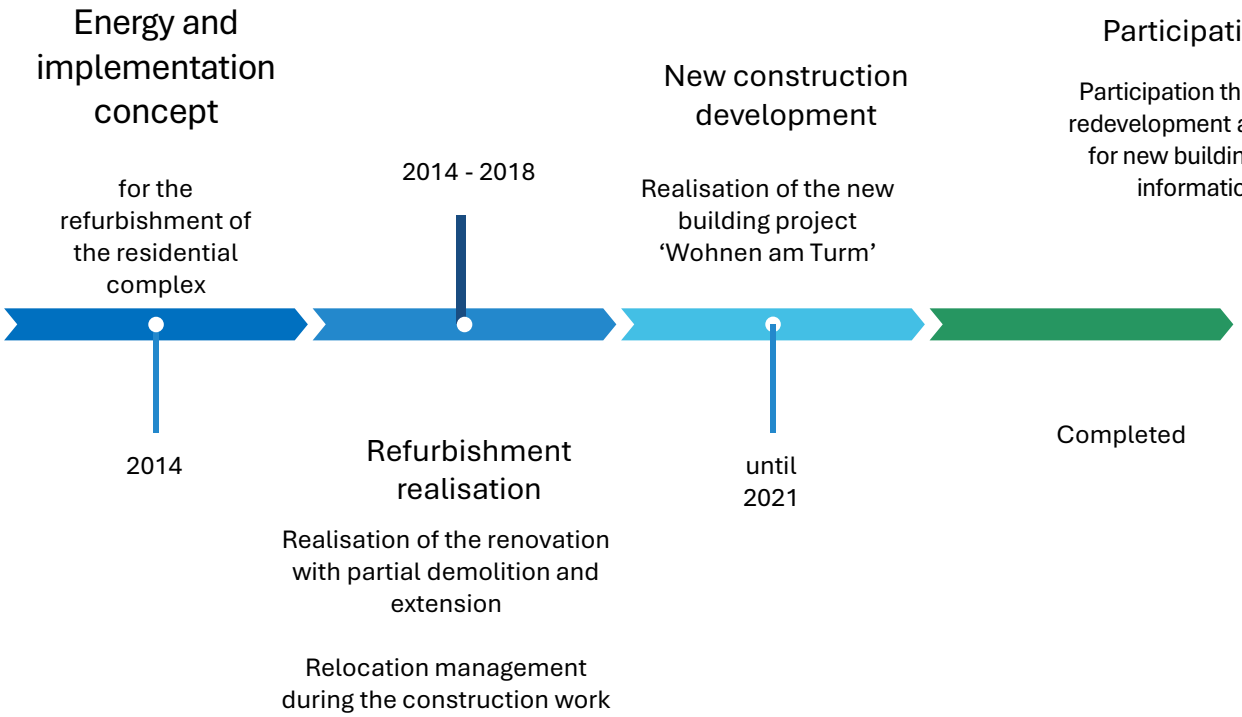

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Measures taken

Energy supply

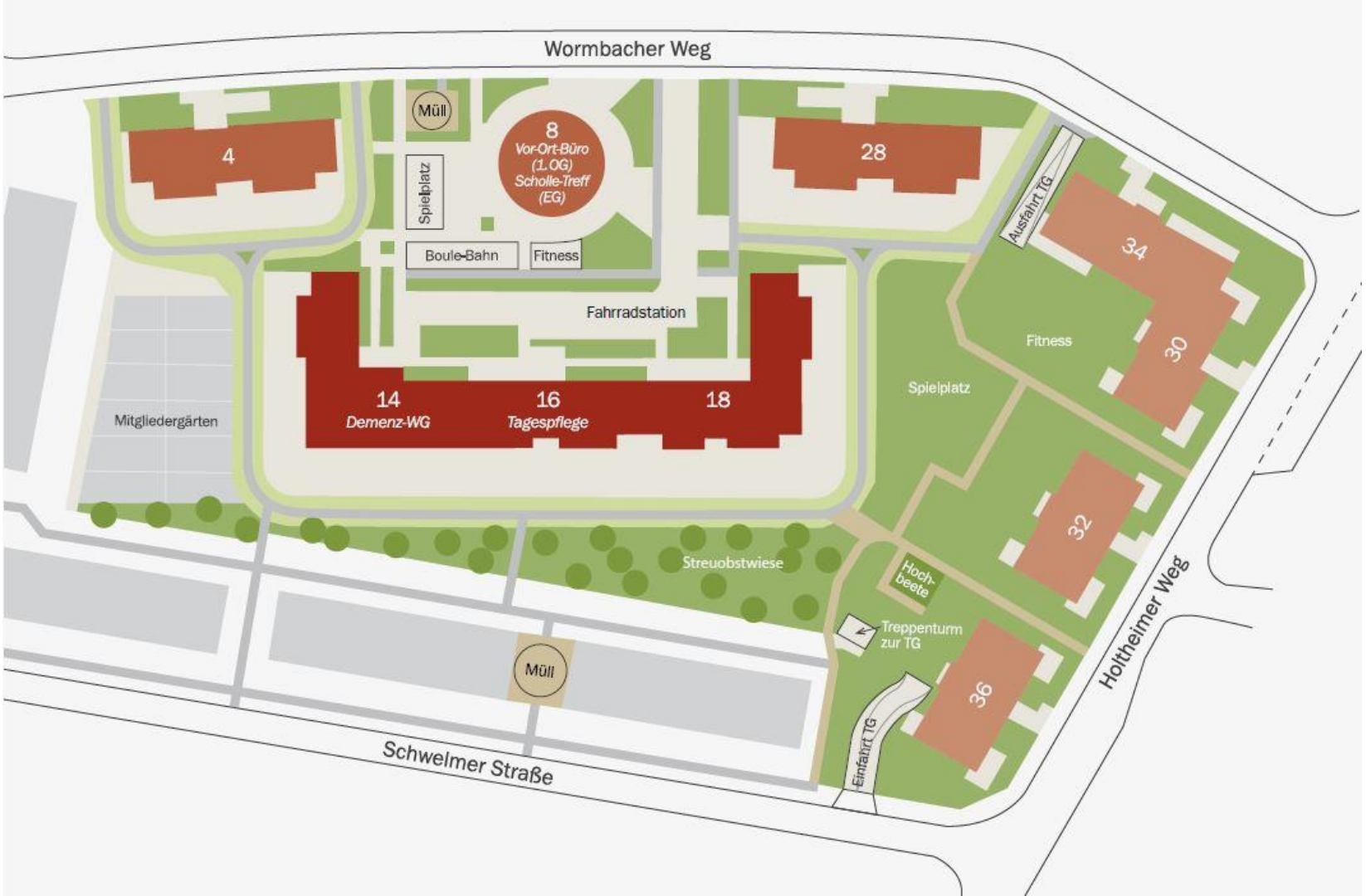
Solar thermal systems, heat recovery from exhaust air (showers, appliances, lighting and solar radiation) and the ‘eTank’ geothermal energy storage tank. This also serves as temporary storage for surplus energy, which is returned as heat when required. Photovoltaics was installed for power generation.

Building refurbishment

Modernisation (radiators, bathrooms, etc.) and energy-efficient refurbishment to KfW85 standard with facade insulation, insulation of basement ceilings and triple-glazed windows.

New flats

146 new flats, flat-sharing community for dementia patients, a day care facility for senior citizens, the Scholl-Treff as a new neighbourhood meeting place and on-site office in the tower, two guest flats, and a wash house.


Wormbacher Weg
Müll
8
Vor-Ort-Büro
(1. OG)
Scholle-Treff
(EG)
4
28
Spielplatz
Boule-Bahn
Fitness
Fahrradstation
Ausfahrt TG
34
30
Fitness
Spielplatz
14
Demenz-WG
16
Tagespflege
18
Mitgliedergärten
Streuobstwiese
32
Hoch-
beete
Treppenturm
zur TG
Müll
36
Einfahrt TG
Holthelmer Weg
Schwelmer Straße

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Conclusion

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Financing

Investment volume	80 mio. € refurbishment 35 mio. € construction project
Sources	Own funds (apportionment to tenants), KfW loan, subsidies
Funding	• 740.000 € subsidy as pilot project by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety • BAFA subsidy (grant) • Bonus funding for the efficient heat pump • Innovation funding for solar thermal systems • KEBAB funding for thermal insulation

Result

Reduction of the primary energy requirement from 210 kWh/m^2 to 30 kWh/m^2 per year. Almost complete independence from electricity and energy supply. The new development has given the neighbourhood social facilities that strengthen the neighbourhood and make it more intergenerational.

Learnings

Combination of refurbishment and new build has enabled cross-financing of the refurbishment.

Despite passing on the costs (3-4 % instead of 11 % in terms of social compatibility) to the basic rent, the warm rent has hardly increased overall thanks to lower energy costs.

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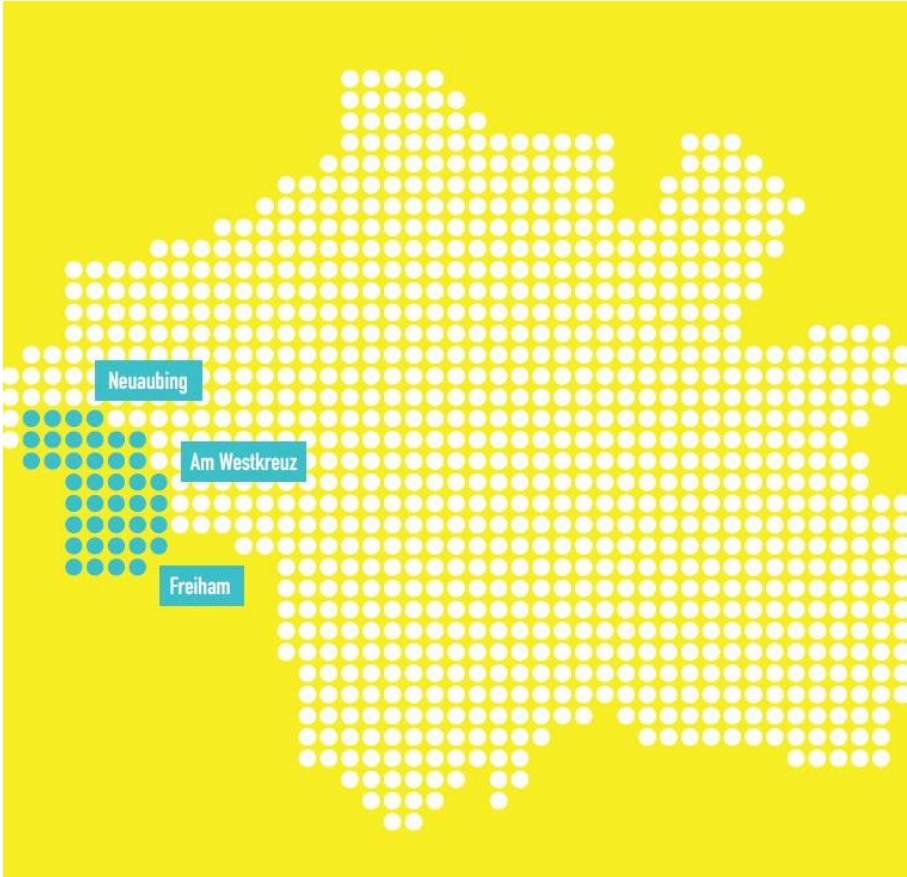
Neuaubing-Westkreuz

Munich

Neighbourhood transformation with a focus on activating WEGs (homeowners' associations) for energy-efficient building refurbishment

Hard facts

Location:	Western outskirts
Size of the area:	255 ha (redevelopment area)
Typology and Age:	Heterogeneous settlement structure with apartment blocks (1960s-1970s), detached houses and historic settlement centre. Neighbouring new-build district of Freiham.
Utilisation structure:	Housing, local supply and social facilities
Number of residents / units:	22.300 residents (redevelopment area)
Ownership structure:	Very diverse, including individual owners, WEGs and municipalities



Initial situation and objectives

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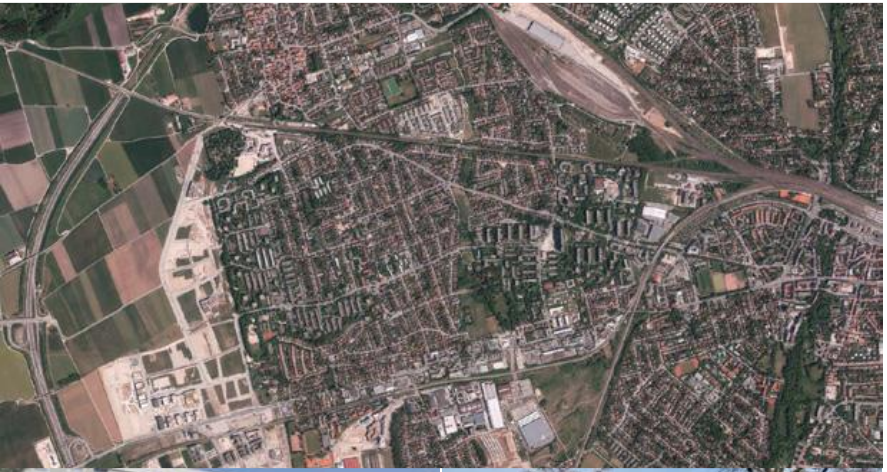

High energy consumption, energy costs and CO2 pollution, mainly due to unrenovated multi-storey residential buildings.

District heating network only expanded in 2008-2012, only 22% of households connected.

The aim is to implement the energy transition in the neighbourhood together with residents by saving energy, switching to renewable energy sources and renovating buildings in a socially responsible manner. A particular focus is on activating individual property owners and homeowner’s associations.

Refurbishment Process

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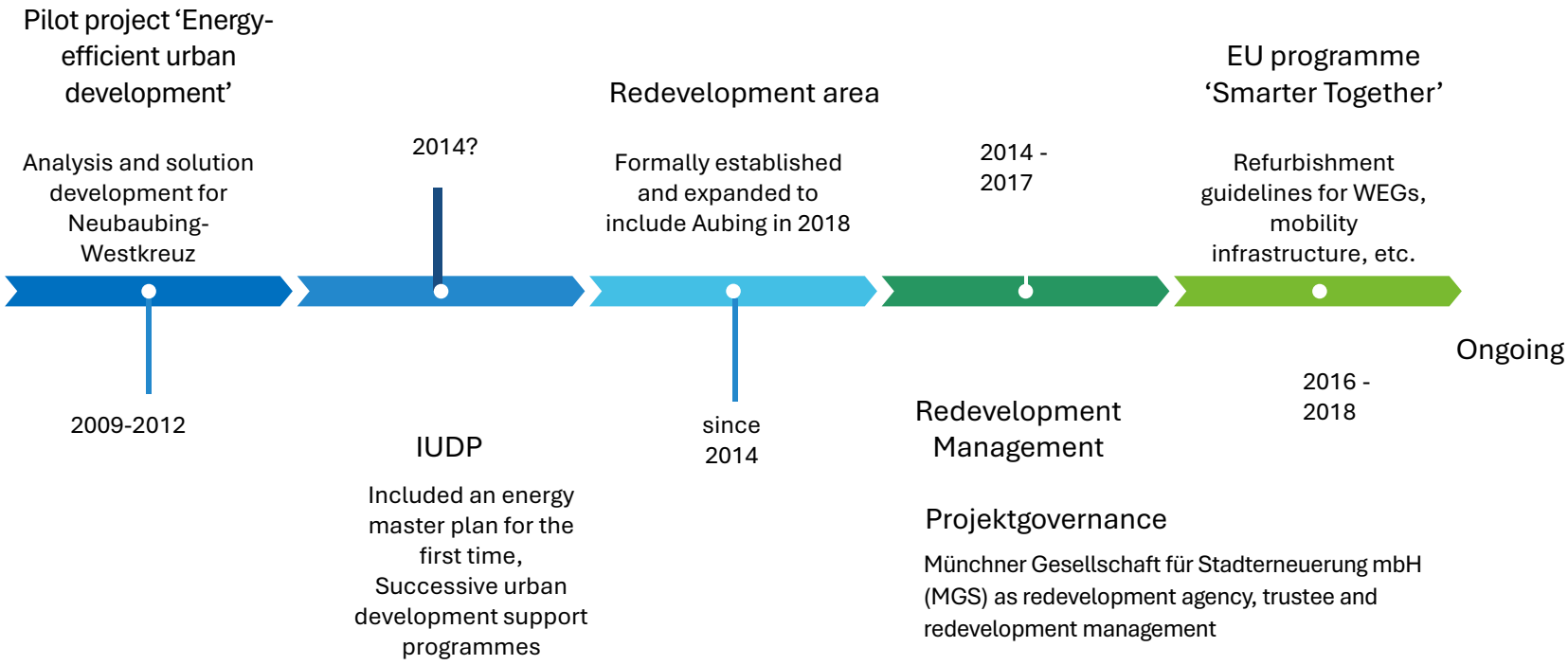
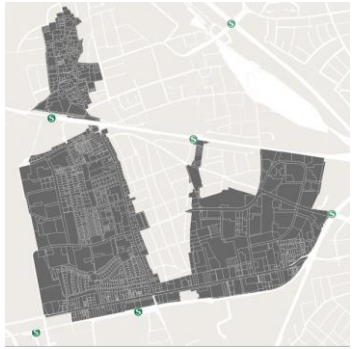


Refurbishment Process



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Pilot project 'Energy-efficient urban development'

Analysis and solution development for Neubaubing-Westkreuz

2009-2012

2014

IUDC

Included an energy master plan for the first time.
Successive urban development support programmes.

Redevelopment area

Formally established and expanded to include Aubing in 2018

since 2014

2014 - 2017

Redevelopment management

Projektgovernance

Münchner Gesellschaft für Stadterneuerung mbH (MGS) as redevelopment agency, trustee and redevelopment management

EU programme 'Smarter Together'

Refurbishment guidelines for WEGs, mobility infrastructure, etc.

2016 - 2018

Ongoing

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Measures taken

Energy counselling

Intensive counselling in the Neuaubing and Westkreuz “Stadtteilläden”by the MGS refurbishment management team. With the free building modernisation and energy check (developed by MGS), they provide technical advice and information on subsidies (KfW, BAFA, municipal funding programme ‘Energy Saving Funding Programme’).

WEG refurbishment

In 2018, WEG Radolfzeller Straße 40-46 completed the refurbishment of its building to KfW Efficiency House Standard 100. It had benefited from the intensive advisory services and was the impetus for the refurbishment projects of other WEGs.

District heating expansion

Expansion of the district heating network and supply with CO2-neutral heat from the new geothermal heating plant in Freiham

Conclusion

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Financing

Investment volume	Unknowen
Sources	divers
Funding	• Urban development support, current ‘Social cohesion’ programme • KfW funding programme • EU programme ‘Smarter Together’ approx. 7 million • Various for building refurbishment of the WEGs

Result

By 2021, MGS had analysed and advised on the energy efficiency of more than 2,000 residential units (1/3 of the total living space). At the same time, more than 42,000 square meters of living space were renovated to a high energy standard.

Learnings

The example shows that the activation of WEGs and individual owners can be successful if advice is provided at a low threshold and free of charge. Focussing on this target group in areas with a diverse ownership structure is key to achieving the energy transition.

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Musikerviertel

Ettlingen

Regional cooperation for the energy transition in neighbourhoods

Hard facts

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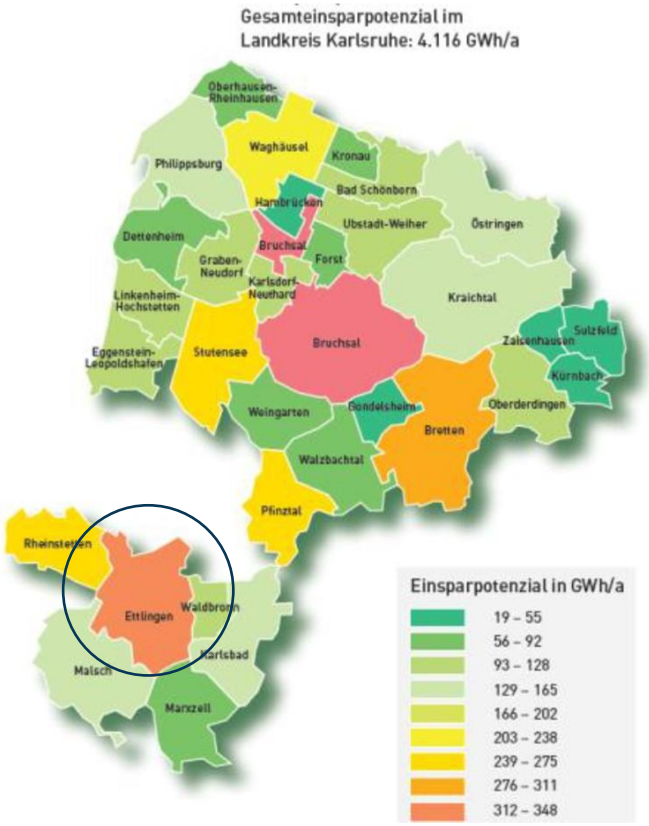
Location:	Centrally located between the old town and the industrial estate
Size of the area:	-
Typology and age:	heterogeneous single-family housing interspersed with large-scale special buildings (schools)
Utilisation structure:	Housing, education and little commerce
Number of residents / units:	271 buildings
Ownership structure:	Private, federal state and municipal

Initial situation and objectives



High potential for energy savings due to low refurbishment rate and fossil fuelled heat supply.

The specific reason for the project was the planned energy-efficient renovation and structural renewal of the Ettlingen Vocational Training Centre (BBZ). The opportunity was seen not only to create a climate-friendly energy supply for the BBZ, but also to make the BBZ the core of a regenerative electricity and heating network for the entire neighbourhood.

Refurbishment Process

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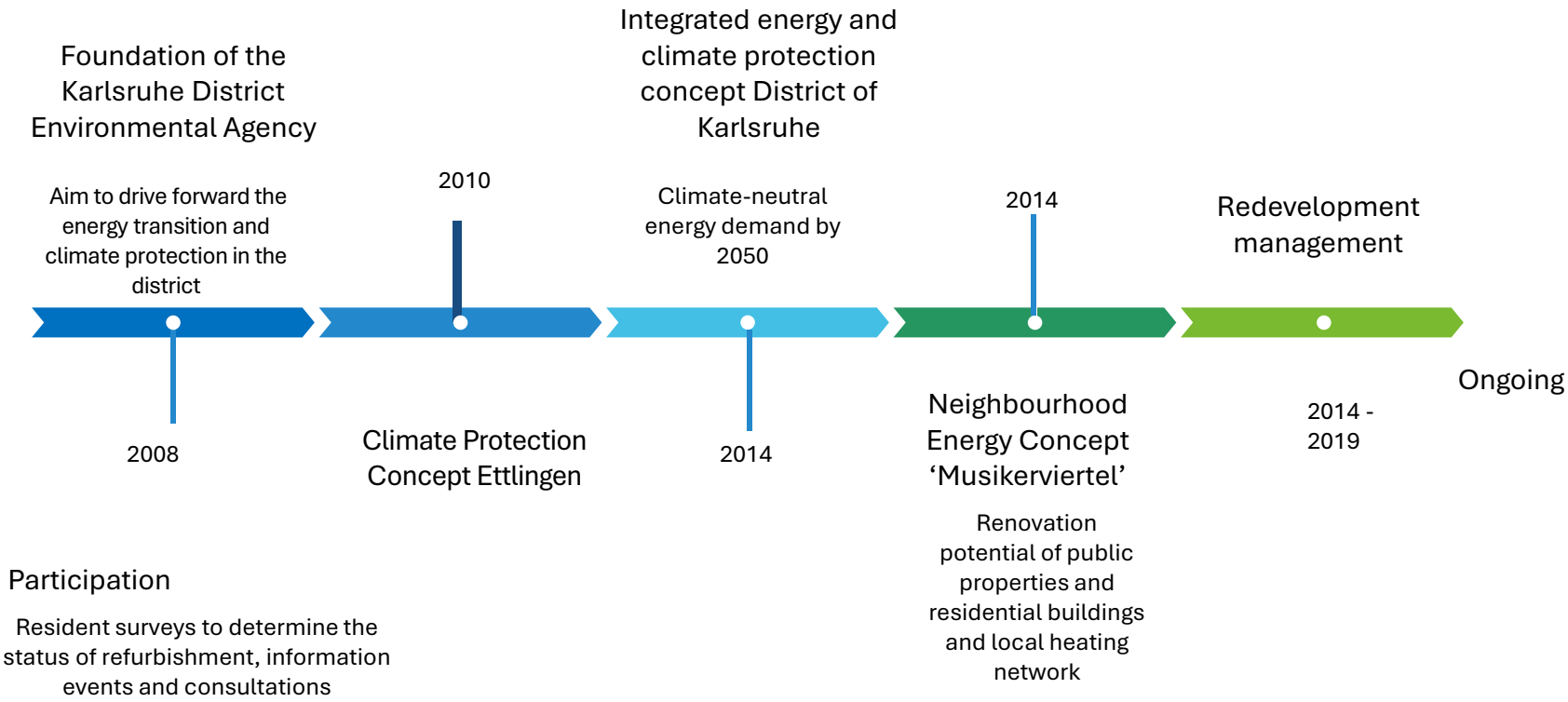

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Measures taken

Regional energy counselling

Free consultations for owners and tenants of private, commercial and municipal buildings were offered in the EAU's RegioMobil (changing locations) on the energy status of their own property, possible renovation measures, energy efficiency and heating technology and funding programmes.

Local heating network

Laid in the ground as a thermally insulated pipeline with a route length of 1,600 meters. It is fed by two pellet boilers (85% of heat generation), a biomethane peak load boiler (10%) and a solar thermal system (5%), all of which are located on the BBZ site. There is also a 100m^3 heat storage tank in the BBZ's new heating centre.

Consumers are the BBZ, 35 apartment blocks (existing and new build), some private residential buildings as well as the new day care centre.

Refurbishment and new construction

Refurbishment or demolition and new construction of three school buildings as well as new construction of four residential buildings and a daycare centre.

Erzeugungsanlagen und Versorgungseinheiten

- 6 Heizzentrale – 2 Pelletkessel & Pelletbunker
- 7 Solarthermie-Anlage (Neubau)
- 8 Bio-Erdgas-Spitzenlastkessel
- 9 Wärme-/Pufferspeicher
- 1 Wärmenetz, Trassen

Verbraucher

- 1 Berufsbildungszentrum (BBZ)
- 2 Wilhelm-Lorenz-Realschule
- 3 Mehrfamilienhäuser
- 4 Mehrfamilienhäuser (Neubau)
- 5 Generationenpark „Festplatz“

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Conclusion

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Financing

Investment volume

139.000 € for the Neighbourhood Energy Concept + X

Sources

Depending on the owner, through own funds from the state, municipality, municipal utilities and co-operative as well as subsidies

Funding

- KfW funding for neighbourhood concept and refurbishment management
- Local heating network subsidised as a climate protection model project by the Federal Ministry for the Environment, Building and Community (NKI)

Result

The heating centre on the BBZ site was built and the local heating network was put into operation in 2020. It is powered by 97% renewable energy and thus saves 1,708 tonnes of CO2 per year.

Learnings

The energy transition can be organised at district level and successfully implemented at neighbourhood level. The close regional cooperation in the energy transition ensures a sensible pooling of resources (for example in the form of the RegioMobil).

The innovative local heating concept ensures the optimised use of different renewable energies depending on the time of year and demand and represents public start-up funding, which is ideally followed by private investment.

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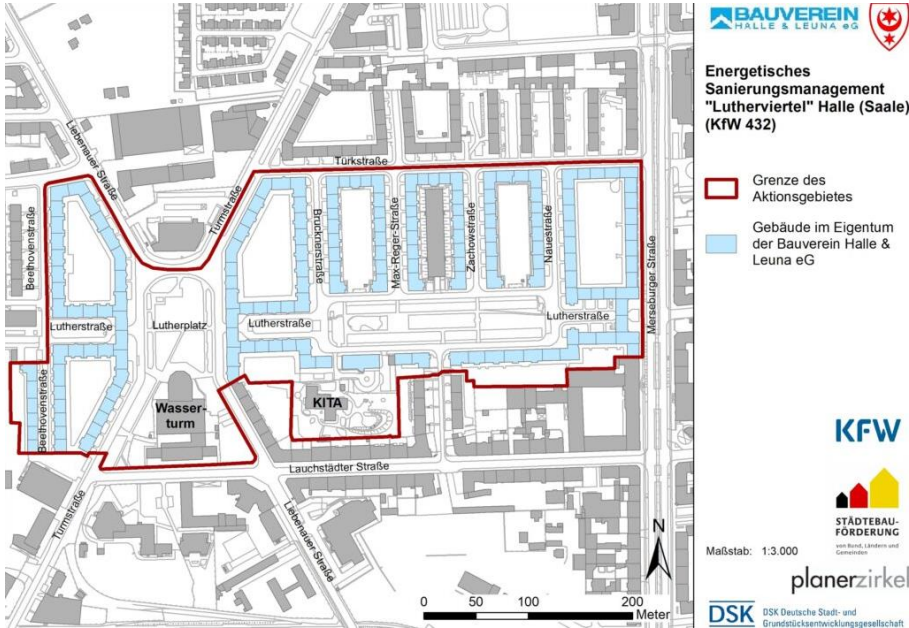
KlimaQuartier Lutherviertel

Halle

Energetic transformation in a neighbourhood with listed buildings

Hard facts

Location:	central
Size of the area:	12,8 ha
Typology and age:	Multi-storey residential building in block structure with the Lutherplatz and water tower at the centre Listed buildings
Utilisation structure:	Residential, some commercial
Number of residents / units:	Approx. 2,500 residents in approx. 1,143 residential units
Ownership structure:	Bauverein Halle & Leuna co-operative, some municipal



Initial situation and objectives

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Inefficient, oversized gas boiler plant with high CO2 emissions

Street space characterised by stationary traffic

Cost stability and energy savings for residents

Increased quality of life

Refurbishment Process

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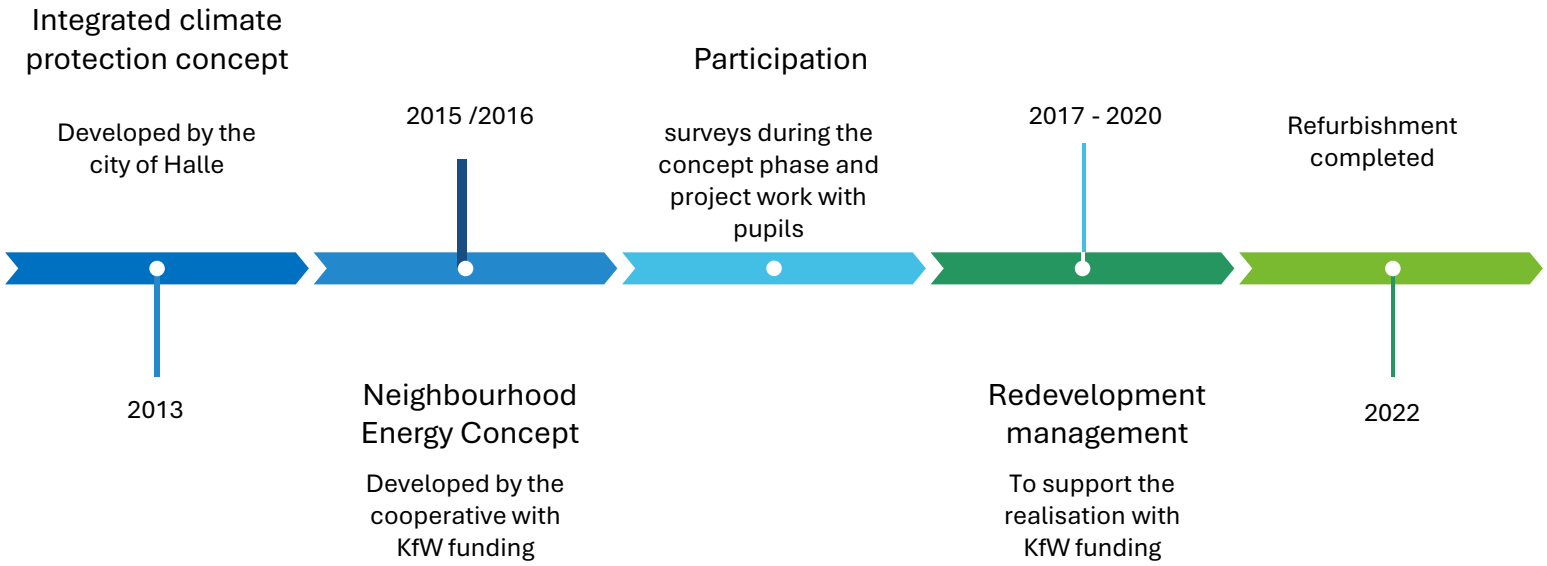

Refurbishment Process

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Integrated climate protection concept

Developed by the city of Halle

2013

2015 /2016

Integrated energy neighbourhood concept

Developed by the cooperative with KfW funding

Participation

urveys during the concept phase and project work with pupils

2017 - 2020

Redevelopment management

To support the realization with KfW funding

Refurbishment completed

2022

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Measures taken

Heat supply

Installation of a new gas-powered combined heat and power plant with 42,000 litre buffer storage (CHP). During peak loads in the CHP unit, district heating is supplied via combined heat and power from the nearby power station. In the future, a power-to-heat module will process the surplus energy using a water storage tank for the hot water supply.

E-mobility

Promotion of e-mobility through a car-sharing fleet and charging points. In addition, free hire of electric bikes for tenants.

Redesign of the courtyards

in terms of accessibility, climate adaptation and biodiversity.

Play and exercise opportunities, new planting structures and rainwater management.

Conclusion

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Financing

Investment volume	5 Mio. €
Sources	Own funds and subsidies
Funding	KfW funding (KfW Programme 432) and urban development support

Result

The installation of the new gas-fired combined heat and power plant has significantly reduced CO2 emissions by 69 per cent (approx. 900 tonnes). The residents benefit from an upgraded living environment.

Learnings

Climate-friendly redesign of neighbourhoods is possible despite monument protection.

Resumee

The approach to refurbishment of urban areas can look very different depending on the local conditions:

- The less diverse the ownership structure in neighbourhoods and houses is, the ‘easier’ it is to implement the refurbishment (especially cooperatives or municipal housing associations). However, with comprehensive advice/support, WEGs can also successfully master refurbishment.
- In urban neighbourhoods, the management structure and the cooperation of all relevant stakeholders play a major role. Regional alliances can also help to drive forward the energy transition, especially in more rural areas.
- The integrated approach helps to obtain fundings. These are often the prerequisite for ensuring that refurbishment projects can be realised in a socially responsible manner.
- There are often synergy effects between existing and new buildings in terms of the cross-financing of renovations by new buildings or the use of newly installed combined heat and power plants to cover the energy requirements of existing neighbourhoods.

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Thank you!

Image sources

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Potsdam Drewitz

Fig. 1: https://www.potsdam.de/de/220-gartenstadt-drewitz-informationsveranstaltung-am-9-april
Fig. 2: https://klimabuendnis-stadtentwicklung.de/vom-problemquartierzum-nachhaltigen-modellstadtteil/
Fig. 3: https://www.potsdam.de/system/files/documents/iekk_drewitz_kurzf.pdf
Fig. 4: https://www.potsdam.de/system/files/documents/iekk_drewitz_kurzf.pdf
Fig. 5: https://www.potsdam.de/de/gartenstadt-drewitz
Fig. 6: https://www.potsdam.de/system/files/documents/masterplan_gartenstadt_drewitz.pdf
Fig. 7: https://www.potsdam.de/system/files/documents/masterplan_gartenstadt_drewitz.pdf
Fig. 8: https://www.potsdam.de/system/files/documents/iekk_drewitz_kurzf.pdf and https://www.kfw.de/stories/umwelt/energieeffizienz/sanierung-gartenstadt-potsdam-drewitz/
Fig. 9: https://www.potsdam.de/de/220-gartenstadt-drewitz-informationsveranstaltung-am-9-april
Fig. 10:https://kis-potsdam.de/artikel/stadtteilschule-drewitz

Potsdam Schlaatz

Fig. 11: https://wir-machen-schlaatz.de/ihre-meinung-ist-gefragt/
Fig. 12: Eigentümerstruktur – Wir machen Schlaatz 2030 (wir-machen-schlaatz.de)
Fig. 13: Sanierungsstand – Wir machen Schlaatz 2030 (wir-machen-schlaatz.de)
Fig. 14: https://wir-machen-schlaatz.de/jann-jakobs-schlaatzgeschichte/
Fig. 15: https://wir-machen-schlaatz.de/arbeit-am-b-plan-beginnt/
Fig. 16: Partizipationskonzept - Schlaatz
Fig. 17: https://www.milanhorst-potsdam.de/veranstaltungen/1915.html

Berlin

Fig. 18: Projekt | Berlin spart Energie (berlin-spart-energie.de)
Fig. 19: maps
Fig. 20: https://ezeit-ingenieure.de/projekt/konzept-analyse-energetische-sanierung-einer-wohnanlage/
Fig. 21: https://ezeit-ingenieure.de/projekt/konzept-analyse-energetische-sanierung-einer-wohnanlage/
Fig. 22: BWP_Quartiere-mit-WP_Web_final.pdf (waermepumpe.de)
Fig. 23: https://www.dbz.de/artikel/dbz_Sanierung_Wohnhaeuser_Lichterfelde_Sued_Berlin-2882951.html
Fig. 24: https://www.maerkische-scholle.de/wohnbezirke-details/steglitz-zehlendorf.html
Fig. 25: Schollen Service Oktober 2021

Image sources

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Fig. 26: maps
Fig. 27: https://www.wirtschaft-muenchen.de/produkt/smarter-together-muenchen/
Fig. 28: https://www.energetische-stadtsanierung.info/wp-content/uploads/2021/11/Steckbrief_Muenchen.pdf
Fig. 29: https://www.neuaubing-westkreuz.de/fileadmin/user_upload/2016.07.01_BuergerbroschuereNeuaubingWestkreuz.compressed-min.pdf
Fig. 30: https://www.neuaubing-westkreuz.de/fileadmin/user_upload/2016.07.01_BuergerbroschuereNeuaubingWestkreuz.compressed-min.pdf
Fig. 31: https://www.neuaubing-westkreuz.de/mitmachen/stadtteilladen-stadtteilmanagement.html
Fig. 32: https://stadt.muenchen.de/infos/smartertogether.html
Fig. 33: https://df-zukunftswerk.eu/aktuelles/entsteht-im-quartier-die-stadt-von-morgen

Ettlingen

Fig. 34: https://bnn.de/karlsruhe/ettlingen/energiewende-in-ettlingen-nahwaerme-fuer-bis-zu-400-wohneinheiten
Fig. 35: maps
Fig. 36: PowerPoint-Präsentation (tandem-staedte.eu)
Fig. 37: PowerPoint-Präsentation (ettlingen.de)
Fig. 38: 20131114_Amtsblatt_Regiomobil.pdf (ettlingen.de)
Fig. 39: https://zeozweifrei.de/schornstein-fur-ettlingen-musikerviertel/
Fig. 40: https://bnn.de/karlsruhe/ettlingen/kita-ettlingen-weitblick-kindergarten-neues-wohngebiet
Fig. 41: https://www.sw-ettlingen.de/Modellprojekt-zeozweifrei-Nahwaerme/Gebiet

Halle

Fig. 42: Energie- & KlimaQuartier Lutherviertel (gebaeudeforum.de)
Fig. 43: https://devel.dasl.de/klimaschutz-im-stadtquartier-das-energie-und-klimaquartier-lutherviertel-in-halle-saale/
Fig. 44: maps
Fig. 45: Energie- & KlimaQuartier Lutherviertel (gebaeudeforum.de)
Fig. 46: https://klimaquartier-lutherviertel.de/schuelerprojekt/
Fig. 47: https://klimaquartier-lutherviertel.de/waermeversorgung/
Fig. 48: IMG_20190122_085016_hdr-Kopie-300x225.jpg (300×225) (klimaquartier-lutherviertel.de)
Fig. 49: Energie- & KlimaQuartier Lutherviertel (gebaeudeforum.de)