

08.01 Building Heating Supply Areas

08.02 Predominant Heating Types

(Edition 1996)

Overview

Types of Fuel for Producing Building Heat

On account of the close relationship between the topics covered in Maps 08.01 - "Building Heating Supply Areas" and 08.02 - "Predominant Heating Types," a common text has been prepared for both maps.

Berlin is the largest contiguous built-up conurbation in Germany. Approximately 3.4 million inhabitants live in an area of 889 km². The development of the building heating supply and the distribution of the various kinds of fuel are tied to the evolution of the city and characterized by its social and building structure.

In the course of the industrialization period after about 1875, and the quick rise in population which proceeded with it, Berlin around the old city center and within the present City-Rail Circle Line developed largely into a city of tenements. At the inner city edge, the first settlements of the housing-construction companies emerged. In the outer areas, villa colonies and garden-city projects were built. Until the end of the 2nd World War, lignite and mineral coal were used almost exclusively for the city's heating supply.

Postwar development was marked by large-scale reconstruction and new building projects, which initially used the row-construction type again. From the 60s to the 80s, large developments and satellite towns emerged in the outer areas, while in the inner city, the housing programs were initially characterized by demolition and new construction. Starting in the mid-70s, preservation-oriented forms of urban renewal were undertaken, primarily in Wedding and Kreuzberg (cf. Map 06.07, SenStadtUm 1995f).

West Berlin

The employment of different fuels for the heating of residential buildings and workplaces developed differently in East and West Berlin during this period. In the **western part of Berlin**, a continuous substitution of coal by other energy carriers took place after the beginning of the 70s. The substitution pattern was dependent on the housing structure: Primarily in the single-family and duplex housing in the outer areas, heating has since been fueled by light oil. In the heating of residential apartment building and work-places, the type of fuel was oriented more toward the proximity of heating-supply networks of the pipe-dependent energy providers, and/or the use of in-plant oil-fired heating units.

The high density of heating power-plants caused by the isolated situation of West Berlin made possible a continuous development of district-heating supply by the Berlin Electric Power Company (BEWAG), even though the priority it gave to electric power supply has so far prevented an optimization of thermal technology planning.

East Berlin

In the **eastern part of Berlin**, lignite and natural gas were used almost exclusively for heating up to 1989, both in single-family and duplex house areas and in multi-story old building quarters, and also in workplaces. About 60% of the housing units in the eastern part of Berlin were provided with single and collective coal heating in 1989; approx. 40% of the apartments were provided with district heat from heating plants and heating-power plants. Because of the use restrictions in the former GDR, fuel oil was not made available to the heating market.

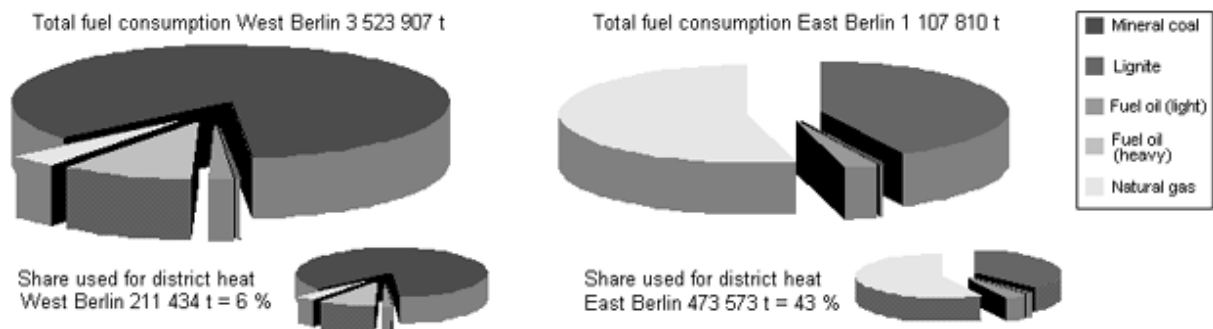


Fig. 1: Total Fuel Use and District Heat Shares in the Berlin Power and Heating Power Plants, 1994

Even today, the overall power supply, including the electric-power share, shows considerable differences between the two halves of the city. Figure 1 shows that for the western part of Berlin, only 6% of the power plant output is available for district heating, while in the eastern part of the city, 43%, or almost half of all output is available for heating supply.

The integration of East Berlin in the eastern power-grid system made it possible even under the former East German regime to provide a predominant share of the output of the four power plants for heating supply purposes.

Since December 1994, the western part of Berlin has been integrated once again into the power-grid system, so that the "energy-island" situation has, after over 42 years, been abolished. Now that all technical requirements have been fulfilled for directly feeding into the BEWAG power supply system, the West Berlin heating power plants, too, have a high potential for expanded district-heating utilization. In the eastern part of the city, modernization of the power plants is continuing by means of such measures as the new construction of the heating power plant Mitte.

The fundamental changes in the heating supply system have provided clear relief in the air-quality situation in the city. The development of the most important pollutants is described comprehensively in the Environmental Atlas Maps 03.01 to 03.08. Sulfur dioxide, dusts and also nitrogen oxide pollution caused by power plants, domestic heating and industry has decreased considerably. For the eastern part of the city, the process of supplemental technical equipment and change of the fuel types will take still more time to have an effect, particularly in the area of domestic heating.

Considering the respectively low emission amounts, the effect of domestic heating measures on the pollutant emission situation is higher than for industry and power plants.

Carbon Dioxide Emissions

Carbon dioxide (CO₂) has in recent years moved to the center of discussion, but it cannot be reduced effectively through technical measures.

The starting points for implementing the political goal of a 25%-reduction in carbon dioxide emissions per capita of the population by 2010 are utmost effectiveness with regard to heating and other energy needs and a generally resource-saving management of all raw materials. In December 1994, the Berlin state government adopted the **Berlin Energy Concept** for this purpose. The main points of the Berlin Concept include the reduction of energy consumption in housing and work-place heating, particularly in public facilities.

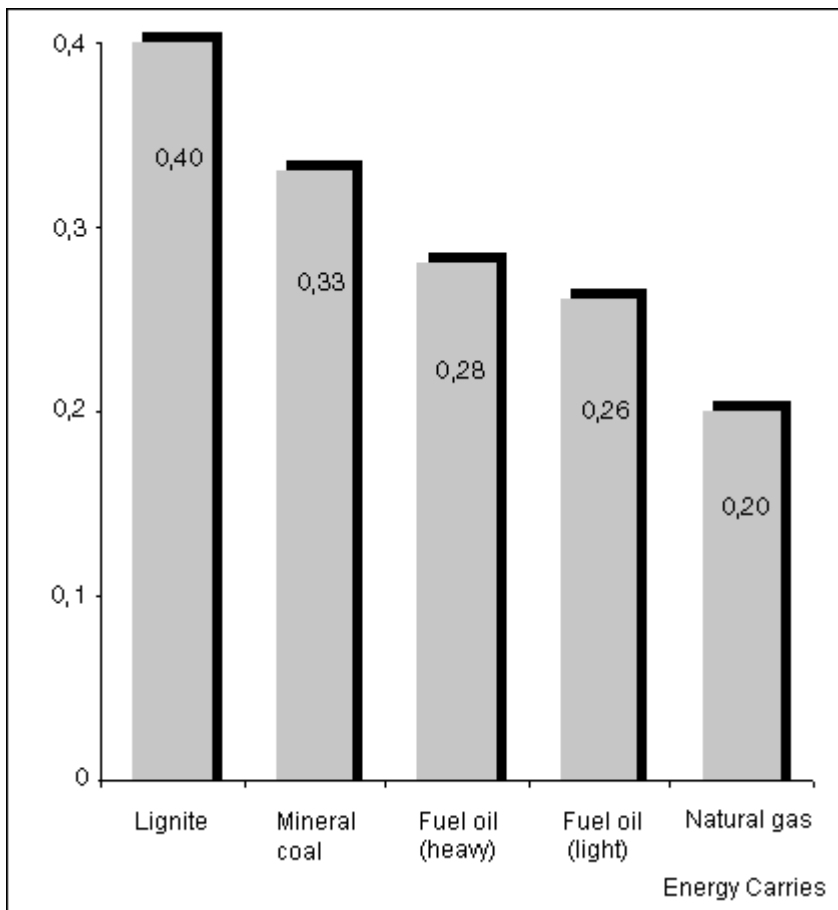


Fig. 2: CO₂ Emissions (kg) per Fuel Use of 1 kWh Primary Energy (c.f. MUNR 1994)

In the area of the largest energy savings potential, housing, about 1.85 mil. tons of CO₂ are to be saved by 2010, compared with 1990. As of 1994, more than 150,000 dwellings had already been reequipped and/or improved from an energy-technology viewpoint (cf. Tab. 1).

Tab. 1: CO₂ Reduction through Publicly-subsidized Rehabilitation Measures on 50,000 Housing Units (HU - WE) in 1991 (percentages relative to CO₂ emission of lignite) (c.f. Valentin 1994)					
Measure	Number of HU (WE)	CO ₂ emissions before the measure, per HU in tons	CO ₂ emissions after the measure, per HU in tons	Reduction in CO ₂ emissions due to the measure, per HU in tons	Reduction in CO ₂ emissions due to the measure, per HU in %
Heating conversion, from lignite to natural gas (only boiler-heating)	1,629	12,67	2.78	9.88	78
Heating conversion, from lignite to natural gas in Weissensee	435	12.67	3.15	9.51	75
Heating conversion, from lignite to natural gas (boiler and radiator)	104	12.67	2.70	9.97	79
Heating conversion, from lignite to natural gas, with complex measures	1,011	12.67	2.42	10.24	81
Heating conversion, from lignite to district heat	1,437	12.67	3.52	9.14	72
Heating conversion, from lignite to fuel oil	1,553	12.67	5.88	6.79	53
Overhaul of district heating system (home transfer station)	6,074	4.89	3.62	1.27	26
Overhaul of district heating system (home transfer station and radiator)	1,078	4.89	3.47	1.42	29
Conversion of district heat (home transfer station)	2,615	4.89	3.37	1.52	31
Conversion of district heat (home transfer station, new radiator, thermostat valves)	3,058	4.89	3.32	1.57	32
Complex measures in district heating-supplied housing	29,011	4.89	3.32	1.57	32
Overhaul of natural gas boilers and new radiators	78	5.32	4.37	0.95	18

Tab. 1: CO₂ Reduction through Publicly-subsidized Rehabilitation Measures on 50,000 Housing Units (HU - WE) in 1991 (percentages relative to the CO₂ emission of lignite) c.f. Valentin 1994

Table 2 shows the reduction in CO₂ emissions in the state of Berlin for the period from 1987 through the first half-year of 1994.

Tab. 2: CO₂ Emissions in the State of Berlin, 1987 to 1994 in millions of tons (c.f. SenStadtUm 1995a)						
	1987	1990	1991	1992	1993	1994 (1st ½ yr.)
CO ₂ Emissions	31.855	30.643	31.297	28.781	28.840	14.394
Electric Power	4.512	3.688	3.309	3.522	3.737	1.824
Import Share						

Tab. 2: CO₂ Emissions in the State of Berlin, 1987 to 1994 in millions of tons (c.f. SenStadtUm 1995a)

For new-construction areas, a low-energy standard applies as a goal, which is at least 20% lower than the standards of the Insulation Ordinance.

Given the immense rehabilitation requirements, but also the many current extensive new building measures, additional conceptual considerations are very important. For this purpose, some 20 energy concepts have so far been prepared which anticipate the greater inclusion of regenerative energy carriers. Thus, about 9.5 billion kWh of power are sold in Berlin per year, but only approx. 200,000 kWhs are obtained directly from the sun, from some 160 photovoltaic plants. In addition, some 1,000 solar thermal plants exist at this time which are used to heat water for immediate use, and for other purposes. The employment of heat pumps for heat energy supply is negligible.

Central to the supply of heating in the city are, by contrast, the 12 BEWAG heating power plants. In addition, there are 40 block-scale heating power plants (as of February 1995) with a total thermal output of 55 MW (by comparison: the HKW Reuter-West: heating power plant in West Berlin produces 650 MW), as well as several hundred public and private furnace plants subject to licensing. Since the

environmental benignness of the district heating depends to a large degree on the fuel used in the plants, Map 08.02.1 shows fuel use for the larger plants in the heating market for 1994.

The present Maps 08.01 and 08.02 show for the first time the current shares of individual energy carriers for housing and workplaces living space in the building blocks. They thus provide a valuable aid for the planned certification of priority areas for district heat and natural gas, and show the current renewal requirements. For new building areas, connection possibilities for the existing supply networks are shown.

Statistical Base

Since the union of the two city halves, residential and commercial buildings - particularly in the eastern part of the city - have been subject to constant change through new construction measures, renovations and shutdowns. This has carried with it rapid change in the heating-energy supply in the city as a whole.

The basic data for the western part of Berlin were provided by the Domestic Heating Emissions Data Base of the Berlin Department of Urban Development and Environmental Protection. These data are as of 1989. In mid-1995, an update of this data base for the whole city was initiated.

For the eastern part of Berlin, the figures of the former East German Housing Policy Data Base were obtained. These data likewise refer to the situation as of 1989.

The lot-level data from both data bases were summed up for the statistical blocks. The area figures from the Emission Data Base for the western part of Berlin represent actually heated areas of housing units. The figures from the East German Housing Policy Data Base are calculated from the number of dwellings multiplied by the average living space size in the statistical block.

Both data bases had to be updated. In addition, the areas available for work-place heating also had to be recorded. Along with other sources, an essential support was provided by the BEWAG and Gas Company (GASAG; cf. Tab. 3).

Tab. 3: Statistical Bases Used and their Geographic Frames of Reference				
	Source	Valid as of:	Figures on:	Geographic Frame of Reference
			Housing (1) Work-places (2)	
Original data:				
Domestic Furnace Emissions Data Base	SenStadtUm	1989	1 / 2	blocks (West Berlin)
Housing Policy Data Base	SenStadtUm	to 1989	1	blocks (East Berlin)
Data update:				
District Heat Supply	BEWAG/EBAG	1994	1 / 2	blocks, single sites, heating and heating power plants
District Heat Supply	Märkisches Viertel District Heating Plant, Neukölln District Heating Plant, EAB Berlin Energy Plants	1994	1 / 2	single properties, blocks, sites heating plants
Block-scale heating power and heating plants	BTB Block-Scale Heating Power Plant Management & Operations Co.	1994	1 / 2	blocks (heated area estimated), single sites, block-scale heating power plants, heating plants)
Gas Supply	GASAG	1994	1 / 2	properties, blocks, statistical areas
Industrial Emissions Data Base - part firing plants subject to licensing	SenStadtUm	1992	1 / 2	plant sites
Public property	SenBau/Wohn	1994	1 / 2	properties
Properties under administration of the Regional Finance Office		1994	1 / 2	properties
Urban planning file	SenStadtUm	to 1989	1 / 2	properties
Conversion of formerly coal-heated building	Chimney Sweeps' Guild	1994	1 / 2	properties in East Berlin, blocks in West Staaken
Plausibility Examination				
Use file of the Environmental Information System	SenStadtUm	1995		block-segments
Geographical frame of reference	State Statistical Office	1994		properties
Urban Planning File	SenStadtUm	to 1989	1 / 2	properties
Storage of materials subject to water damage	SenStadtUm	1994	1 / 2	properties
New housing construction after 1989	SenBau/Wohn	1994	1	boroughs

Tab. 3: Statistical Bases Used and their Geographic Frames of Reference

Despite the copiousness of these investigated statistical bases, it was, due to the upheaval in the heating market, not possible to obtain complete figures in all cases. This applied particularly to the area of commercial and industrial sites, and as well as to the eastern part of the city. Single sites with only very small areas, such as forest ranger's houses, churches or excursion restaurants, were likewise not covered.

Methodology

The existing area, block and/or lot-specific data bases on housing and work-place heating have been compiled for graphic representation of the block or block-segment level. Of the approx. 25,000 statistical blocks and/or block segments of the Environmental Information System (UIS) of the Berlin Department of Urban Development and Environmental Protection, those which show an at least predominant structural use have been shown on the map. The figures recorded for the entire block were transferred to all built-up segments according to their area share of the block (cf. Map 06.01, SenStadtUm 1995e).

The representation of the results on two separate maps is designed to show clearly both an overview of the break-down by energy carrier (Map 08.01), and the fuel used on the respective block and/or possible mixed supplies (Map 08.02). Map 08.02.1 shows the most important district heat production sites. The fuels used for residential and work-place heating were grouped together under five heating types: district heat, gas, oil, coal and nighttime power storage heating.

On **Maps 08.01.1 to 08.01.4**, the heating types district heat, gas, oil and coal are shown. The proportional share of each fuel in the total heated area of the block is represented, provided that share is at least 5%. Buildings heated by nighttime power-storage heating are not shown separately, because of their small overall share (1.2% of the total heated area).

The representation of each fuel is accomplished with the same coloring. Lighter shades represent less densely-built blocks (less than 5,000 m² of heated area), combined with a slighter share of the energy carrier concerned for the overall heated area; conversely, the darker shades show densely populated areas and the dominating influence in the block of the respective fuel shown on the four single maps (15,000 m² or more heated area).

On **Map 08.02 – Predominant Heating Types**, the characteristic type of heating for each block is shown. The color shadings for all five fuels, from yellow for natural gas to purple for coal is designed to show the increasing share of air pollutant potential for each material. A special problem involves the district-heating supply. Of course, no emissions occur at the consumer level from these 35 district-heating networks run by different enterprises, but the fuel use at the point of production is what is significant. This can be seen for selected plants on **Map 08.02.2**.

A heating type is shown as predominant if its share of the heated area in the block totals more than 40% and the difference to the second-highest fuel used in the block is greater than 20%. For the differentiation of the proportional shares between 40 and 100%, a linear percentage class division is undertaken, with three levels. These levels are shown by means of a graduated coloring within the primary color.

If no predominant heating type is indicated on the basis of the distribution of proportional shares of heating types in a block and/or the block-segment, these shares are attributed respectively to one of the seven mixed categories. The graphic differentiation of the mixed categories is shown by coloring and cross-hatching.

The entire heated area within a block and/or block segment area is the reference base for the proportional assignment of the individual heating types. The average heated area for living and work per block totals approx. 9,100 m². The representation of the entire heated area in the block and/or in the block segment area is shown by means of a three-stage symbolic labeling. The average heated area of all blocks is approx. the median value of Level 2, or „5,000 to 15,000 m²“.

Map Description

The graphic display of the evaluated heating structure data for the residential and work-places in Berlin provides information both on larger-scale contiguous areas and on block-segment areas.

Map 08.01 – Building Heating Supply Areas

The dependence of the fuel use on building structure and location in the city is clear even at the level of the 23 municipal boroughs. There is a clear predominance of coal in the inner city districts, or district heating in the East Berlin boroughs with a high share of large-scale developments (cf. Tab. 4).

Map 08.01.1 – District Heating Supply Areas, shows clearly the local proximity of heating plants and heating power plants to their respective service areas. The largest share of the total district heating supply in Berlin is provided by the BEWAG, with a network totaling some 1,000 km. The great majority of the 2,208 blocks provided with district heat show high proportions of district heat supply (greater than 60%). In the new high-rise residential areas on the outskirts, such as Hohenschönhausen, Marzahn or the Märkisches Viertel, contiguous residential areas are completely provided with district heat. Altogether, the depiction makes clear the Berlin's leading position in the share of district heat supply Europe-wide. However, there is great potential for additional connection of coal-heated old building at the edge of district-heating-supplied areas.

Map 08.01.2 – Gas Heating Supply Areas, shows the finely meshed distribution of the network over the entire built-up area of Berlin. The proportional shares of the total heated area in the respective statistical blocks are generally between 10 and 40%. High gas supply shares are evident in only a few

blocks, e.g. apartment blocks in Spandau, Zehlendorf, Britz, Reinickendorf, Pankow and Köpenick, as well as individual commercial, administrative and service locations distributed throughout the city. Due to the widespread distribution of natural gas lines in the urban area, a large potential for expansion exists, analogously to that for district heat.

Until the reunification of the two city halves, there was practically no oil-fueled building heating in the eastern part of Berlin. Map **08.01.3 – Oil Heating Supply Areas**, which shows the supply situation as of 1993-94, still indicates this fact very clearly. While in the western part of the city, oil-fired heating supply plays a very dominant role (approx. 42% of the entire heated area of West Berlin), the eastern part (approx. 3.5% of the entire heated area of East Berlin) so far shows a clear increase only for single-family and duplex house areas (cf. Tab. 4 and Fig. 3).

Tab. 4: Residential and Work-place Heating in the Berlin Boroughs in 1994, by Heating Types in %						
Borough	Heated Area in m2 (rounded up)	District Heat	Gas	Oil	Coal	Night Storage
Mitte	5,521,000	61.0	17.1	2.8	19.0	0.1
Tiergarten	5,057,000	45.5	13.4	23.7	16.4	1.0
Wedding	7,194,000	24.3	22.6	32.4	19.5	1.2
Prenzlauer Berg	6,965,000	14.4	29.8	0.8	54.8	0.2
Friedrichshain	3,804,000	37.6	19.6	2.8	40.0	0.0
Kreuzberg	6,859,000	13.1	27.4	34.1	23.8	1.6
Charlottenburg	11,563,000	45.9	19.0	27.4	7.0	0.7
Spandau	11,843,000	10.0	19.9	57.2	10.0	2.9
Wilmerdorf	8,130,000	32.7	13.7	44.9	7.1	1.6
Zehlendorf	6,325,000	14.9	29.1	49.8	4.8	1.4
Schöneberg	7,512,000	12.1	26.9	43.9	15.6	1.5
Steglitz	9,434,000	26.7	18.9	44.4	8.7	1.3
Tempelhof	9,965,000	0.4	27.1	62.6	8.3	1.6
Neukölln	15,076,000	29.6	20.1	33.6	14.8	1.9
Treptow	4,086,000	15.7	37.8	6.8	39.2	0.5
Köpenick	5,039,000	16.6	33.8	7.0	42.6	0.0
Lichtenberg	7,592,000	66.6	12.4	1.9	19.1	0.0
Weissensee	1,961,000	10.4	44.2	6.0	39.3	0.1
Pankow	4,597,000	32.6	33.7	2.8	30.7	0.2
Reinickendorf	12,235,000	21.7	23.8	45.7	6.5	2.3
Marzahn	6,357,000	87.3	3.6	2.3	6.8	0.0
Hohenschönhausen	4,560,000	75.2	11.5	5.3	8.0	0.0
Hellersdorf	4,000,000	73.4	6.1	4.8	15.7	0.0
West Berlin	111,193,000	23.0	21.7	42.3	11.3	1.7
East Berlin	54,482,000	47.6	20.9	3.5	27.9	0.1
Berlin (total)	165,675,000	31.1	21.4	29.5	16.8	1.2

Tab. 4: Residential and Work-place Heating in the Berlin Boroughs in 1994, by Heating Types

The further development will depend essentially on the extent to which the plan for district heat and natural gas supply precedence areas provided in the Berlin Energy Concept is implemented.

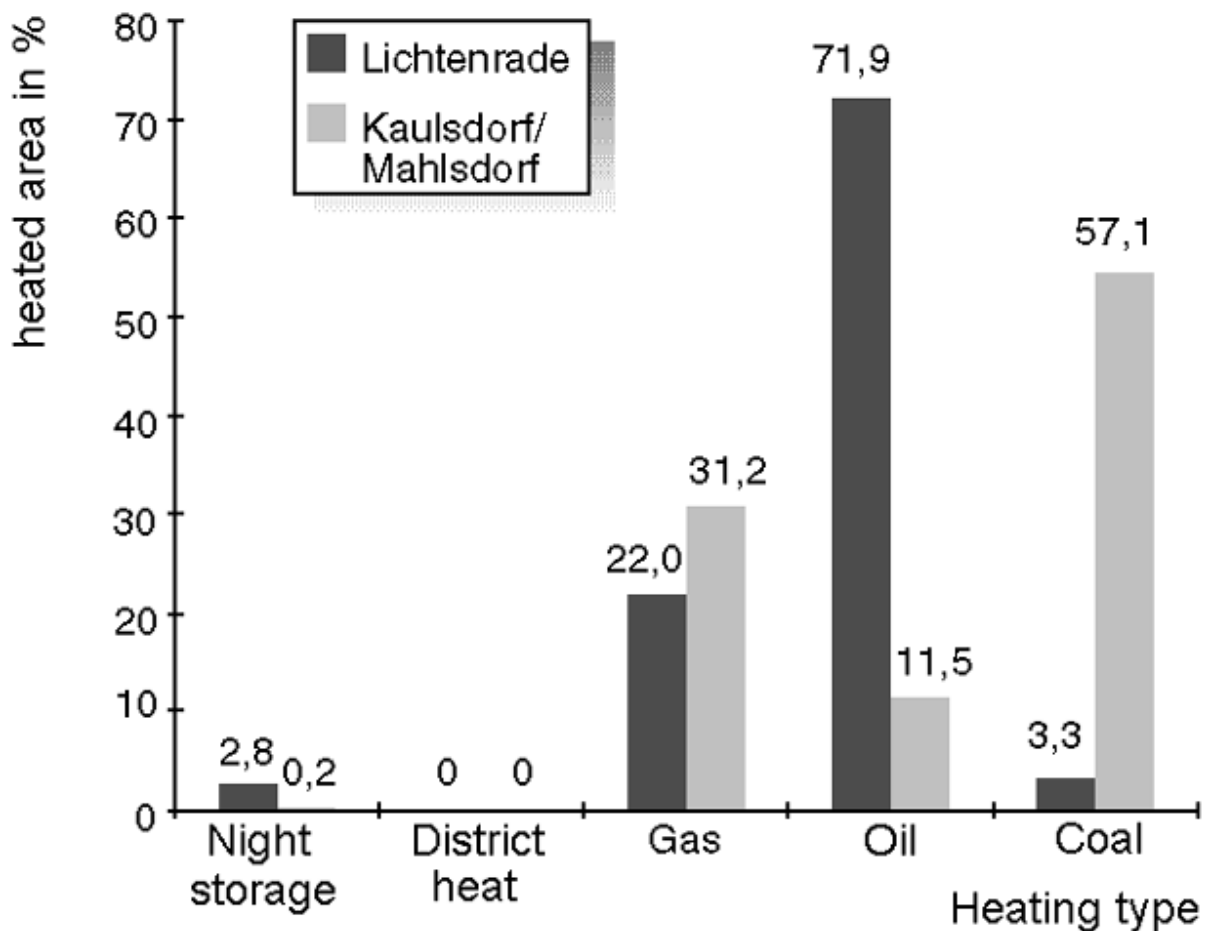


Fig. 3: Shares of Individual Heat Energy Types in Blocks with Single-Family and Duplex House Development in Lichtenrade and in Kaulsdorf/ Mahlsdorf in 1994 (apartment blocks with the predominantly development structure "Yard type")

With the exception of the district-heating supply concentration areas, a certain degree of oil-fueled building heating can be found in nearly all blocks in West Berlin. Particularly commercial sites, modernized old building quarters and suburban housing developments show a high share of oil heating systems. In single-family and duplex house areas, oil is the predominant fuel for building heating; the oil share of the total heated area in these blocks is often far above 60%.

Despite widespread conversion measures in the public and private areas, coal is still used for heating a considerable proportion of the city, especially in the inner city boroughs of East Berlin (cf. Fig. 4).

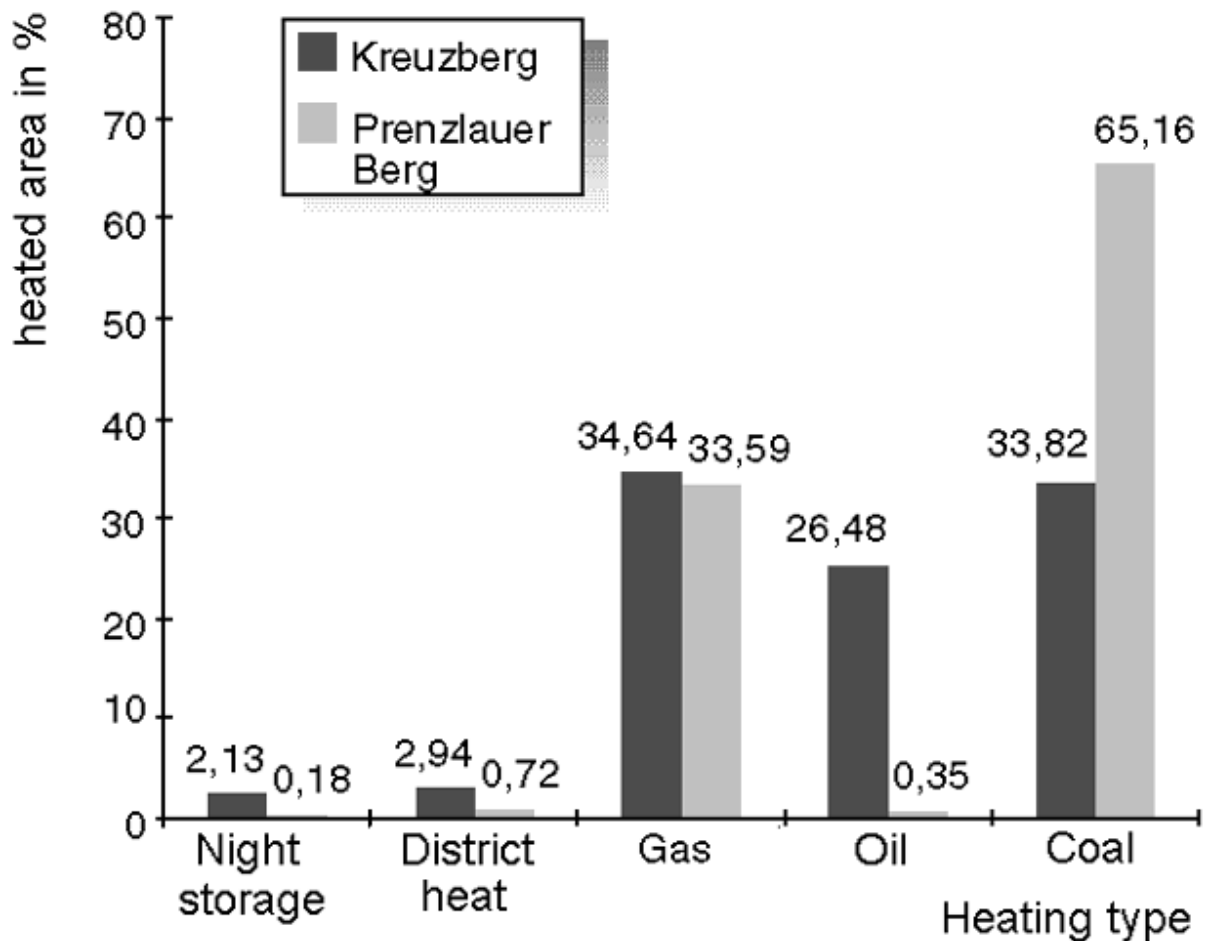


Fig. 4: Shares of Individual Heat Energy Types in Kreuzberg and Prenzlauer Berg in 1994 (apartment blocks of the "Late 19th-century development" type)

However, Map 08.01.4 – Coal Heating Supply Areas, also shows clearly that in the single-family and duplex housing areas in the eastern part of Berlin which, in 1989, were almost exclusively coal-heated, coal had, five years later, already been widely displaced by fuel oil or (liquid) natural gas. In the western part of the city, the use of solid fuels in the energy sector is proportionally only about a third of that in the eastern part, and will decrease further. What cannot be directly seen from the representation is the fact that in the area of district heat, the lion's share of fuel for the large heating power plants of the BEWAG continues to come from mineral coal, occupying more than 80% of energy carrier use (cf. Map 08.02.2).

Map 08.02 – Predominant Heating Types

In this map, the still very different heating structure of both city halves can be seen. In the western part, fuel oil is the dominant fuel for building heating. Generally, the same share of gas and district heat can be found in the East and West, albeit with clearly different distribution structures.

While in blocks in the western inner city area, the oil accounts for approx. 40% of the total usage, the share of this heating type reaches levels exceeding 80% in the western outskirts

In the eastern part of the city, in addition to the very high share of district-heat, coal continues as the predominant fuel used for residential and work-place heating, particularly in the old-building areas of the inner city, as well as in single-family and duplex house areas on the outskirts of town. Here, however, a further significant shift toward installation of other energy carriers can be assumed.

The fact that 21% of all Berlin residential and work-place space is heated with gas does not emerge from the representation so clearly because of the relatively even distribution of the gas supply over the entire urban area. Aside from small concentration areas in Pankow, Treptow and Köpenick, such mixtures of heating types as gas/coal are the rule in East Berlin. As a result of the conversions of the last years, many blocks in single-family and duplex house areas on the outskirts of town already have a combination of gas, oil and coal, whereby the main energy carriers in the future will be fuel oil or

gas. In the western part, mixed supply with gas and oil is predominant in areas with closed block development, for instance in Schöneberg, Tiergarten, Wedding and Tempelhof, and also in Spandau and Reinickendorf.

In addition to the outskirts areas of East Berlin with a high share of coal heat, the inner-city multi-story old building areas of Friedrichshain, Prenzlauer Berg and Pankow have a very high proportion of individual coal heating. These old building areas adjoin district-heat-supplied areas both to the east and to the west.

With regard to the further development of the heating stock, the most important areas, in addition to the mixed-supply areas, are those areas where different supply structures are directly adjacent. Due to the spatial proximity, good opportunities exist in both cases to develop the energy carriers district heat and gas further.

Map 08.02.2 – Fuel Use of Significant Heating Plants and Heating Power Plants shows the differences at the power plant level in the choice of energy carriers used. The over 80%- market share of mineral coal use for heating at the eight BEWAG heating power plants in West Berlin contrasts with the four heating power plants in the eastern part of the city, with their natural gas share of almost 60%. Moreover, in East Berlin, the lignite proportion of almost 40% of solid fuels constitutes a relevant factor, compared with less than 1% in West Berlin (cf. also Fig. 1).

Literature

- [1] **Berliner Kraft- und Licht-Aktiengesellschaft (BEWAG) (Hrsg.) verschiedene Jahre:**
Informationsbroschüren zur Fernwärmeversorgung und zu den Heizkraftwerken, Berlin.
- [2] **Ehlert, D. 1995:**
Status-Quo-Analyse an Blockheizkraftwerken (BHKW) im Land Berlin, Gutachten im Auftrag der Senatsverwaltung für Stadtentwicklung und Umweltschutz, Berlin not published.
- [3] **GASAG Berliner Gaswerke (Hrsg.) ohne Jahr:**
Informationsbroschüren zur Erdgasversorgung in Berlin, Berlin.
- [4] **KommTeam ABS e. V. 1995:**
Bericht zur Emissionsentwicklung im Bezirk Berlin-Köpenick 1994/1995, Untersuchung im Auftrag des Bezirksamtes Köpenick von Berlin, Abt. Gesundheit und Umwelt, not published.
- [5] **MUNR (Ministerium für Umwelt, Naturschutz und Raumordnung des Landes Brandenburg) (Hrsg.) 1994:**
Klimaschutzbericht Land Brandenburg, Potsdam.
- [6] **SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1992:**
Energiekonzept Berlin, Entwurf für die Öffentlichkeitsarbeit, Neue Energiepolitik für Berlin, Heft 9, Berlin.
- [7] **SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1993:**
Energiesparen in öffentlichen Gebäuden, Neue Energiepolitik in Berlin, Heft 11, Berlin.
- [8] **SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1995a:**
Energiebedingte CO₂-Emissionen in Berlin 1991 – 1994, Materialien zum Energiekonzept Berlin, Heft 7, Berlin.
- [9] **SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1995b:**
Photovoltaik für Berlin, Materialien zur Energiepolitik in Berlin, Heft 13, Berlin.
- [10] **SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1995c:**
Energiekonzept Berlin, Materialien zur Energiepolitik in Berlin, Heft 14, Berlin.
- [11] **SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1995d:**
Luftreinhalteplan, Heft 19 der Informationsreihe zur Luftreinhaltung in Berlin, Berlin.

- [12] **Valentin, Dr.-Ing. G. 1994:**
Auswirkungen von energiesparenden Maßnahmen an zentralen Heizungs- und Warmwasseranlagen von Wohnungsbaugesellschaften im Ostteil Berlins, Gutachten im Auftrag der Senatsverwaltung für Bau- und Wohnungswesen, Berlin.
- [13] **Vereinigung Deutscher Elektrizitätswerke VDEW e.V. (Hrsg.) 1993:**
Heizungssysteme im Vergleich, Energiewirtschaftliche Studien im Vergleich, Band 1, Frankfurt am Main.

Maps

- [14] **Berliner Kraft- und Licht-Aktiengesellschaft (BEWAG) (Hrsg.) 1994:**
Fernwärmenetze in Berlin, Übersichtskarte 1: 50 000, Berlin.
- [15] **GASAG Berliner Gaswerke (Hrsg.) 1995:**
Gasversorgung in Berlin, Übersichtskarte 1:50 000, Berlin.
- [16] **SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1994a:**
Umweltatlas Berlin, aktualisierte und erweiterte Ausgabe 1994, Karte 03.01 Schwefeldioxid - Emissionen und Immissionen, 1:200 000/1:300 000, Berlin.
- [17] **SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1994b:**
Umweltatlas Berlin, aktualisierte und erweiterte Ausgabe 1994, Karte 03.03 Stickoxide - Emissionen und Immissionen, 1:200 000/ 1:300 000, Berlin.
- [18] **SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1994c:**
Umweltatlas Berlin, aktualisierte und erweiterte Ausgabe 1994, Karte 03.04 Stäube - Emissionen und Immissionen, 1:200 000, Berlin.
- [19] **SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1994d:**
Umweltatlas Berlin, Ausgabe 1994, Karte 03.08 Organische Gase - Emissionen und Immissionen, 1:200 000/1:300000, Berlin.
- [20] **SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1995e:**
Umweltatlas Berlin, aktualisierte und erweiterte Ausgabe 1995, Karte 06.01 Reale Nutzung der bebauten Flächen, 1:50 000, Berlin.
- [21] **SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1995f:**
Umweltatlas Berlin, Ausgabe 1995, Karte 06.07 Stadtstruktur, 1:50 000, Berlin.