WHAT'S HAPPENING IN **SAXONY** & UPPER AUSTRIA?

Architect Owner invests in upgrade for long term

Multifamily Retrofit

Location: Chemnitz (near Dresden) Saxony, Germany

Building Type: 4 apartments

Architect: Matthias Taube Planugsburo Chemnitz

Year built: 1911 / 2007
Size: 446 m2
Cost: 950 Euro/ m2

Multifamily Retrofit

Enclosure:

- Exterior Insulation over masonry
- Triple glazed windows
- Semi conditioned basement with exterior insulation below grade

Design Energy Standard:

Achieved Passivhaus

Energy Use:

Measured data shows

- 25 kWh/m2 A for heating
- 102 kWh/m2 A primary
- 11 watts per m2 peak
- 0.49 ACH 50

see data in following pages

Multifamily Retrofit

Before and after Envelope comparisons

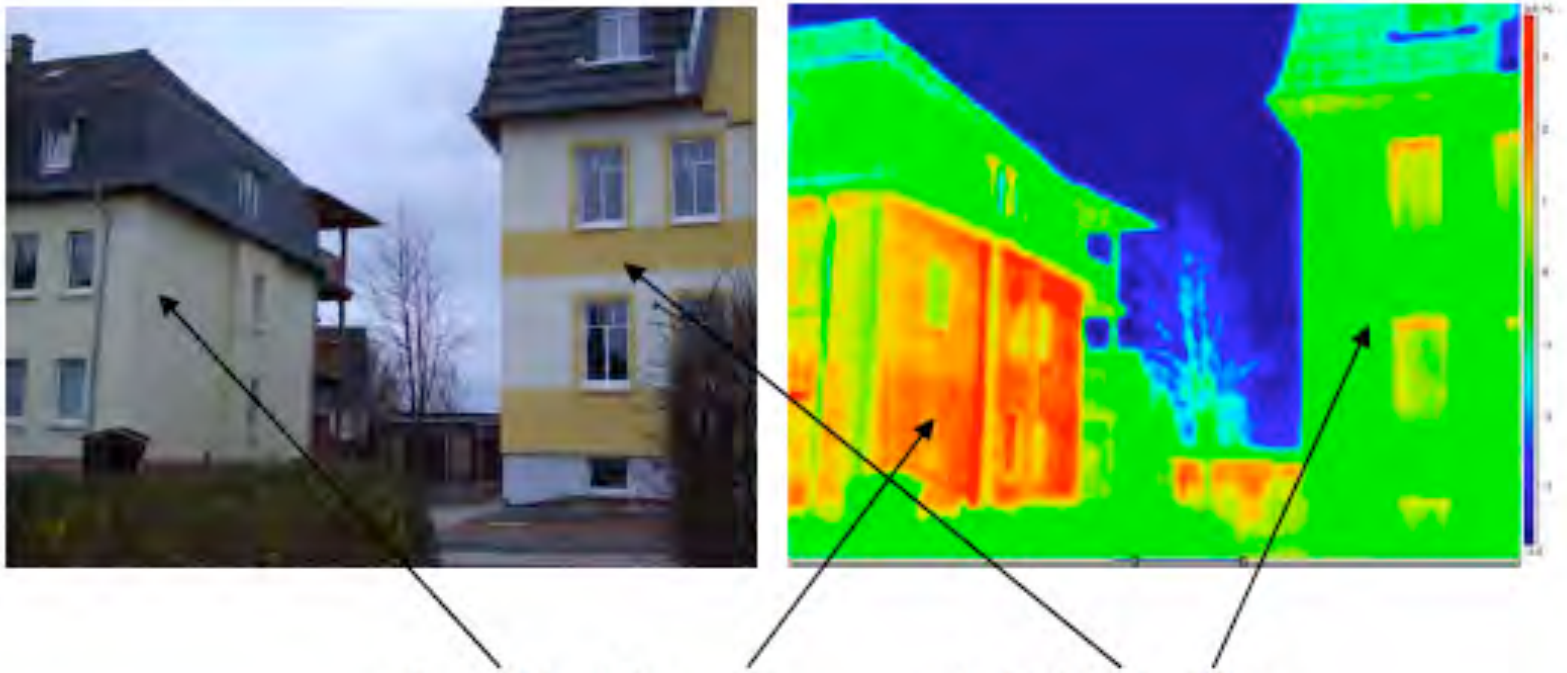
data	
Energiebezugsfläche A_{EB}	445.6 m²
no. of storey propers	3 + top floor
heating demand (PHPP)	25.00 kwh/m²
required annual heat consumption (PHPP)	11,100 kwh
heating load	11 W/m²
primary energy demand (PHPP for hot water, heating, domestic and operating electricity)	101.20 kwh/m²a
airtightness (Blower Door Test)	0.49 h^{-1}
costs DIN 276 (Kgr.300+400)	950 €/m² living space

1.3. *Comparison*

Component	prior to refurbishment	after refurbishment	improvement
outer wall (ground floor, upper floor)	1.46 W/(m²K)	0.157 W/(m²K)	89 %
outer wall (top floor)	1.92 W/(m²K)	0.157 W/(m²K)	90 %
basement ceiling	1.78 W/(m²K)	0.216 W/(m²K)	87 %
kerb roof	0.86 W/(m²K)	0.08 – 0.13 W/(m²K)	~ 87 %
roof	-	0.13 W/(m²K)	-
windows	3.5–5.0 W/(m²K)	0.80 W/(m²K)	80 %
Heat loss (H_T')	1.49 W/(m²K)	0.28 W/(m²K)	82 %
primary energy demand (Q_P)	359.68 kWh/m²a	34.6 kWh/m²a	92 %
Anlagenaufwandszahl (EnEV)	2.01	0.71	65 %
greenhouse gas emissions	410.43 kg/m²Na	9.87 kg/m²Na	98 %

Greenhouse gas emissions are reduced by 115.772,00 kg/a in total.

Multifamily Retrofit



adjacent building
not refurbished,
no insulation measures

refurbished building
20cm WDVS

Multifamily Retrofit

Remarkable Features:

•Exceptional Envelope and reconstruction of the building
•Detailed data and understanding of the energy and resource use of the building by the Owner

Potential Issues:

•Complex mechanical system that without invested Owner could be problematic- expensive compared to loads satisfied
•Notice cooking odor in hallway and wonder if this is due to the central ERV or simply airselaing between apartments and gasketing doors.

Multifamily Retrofit

Balconies without a thermal bridge

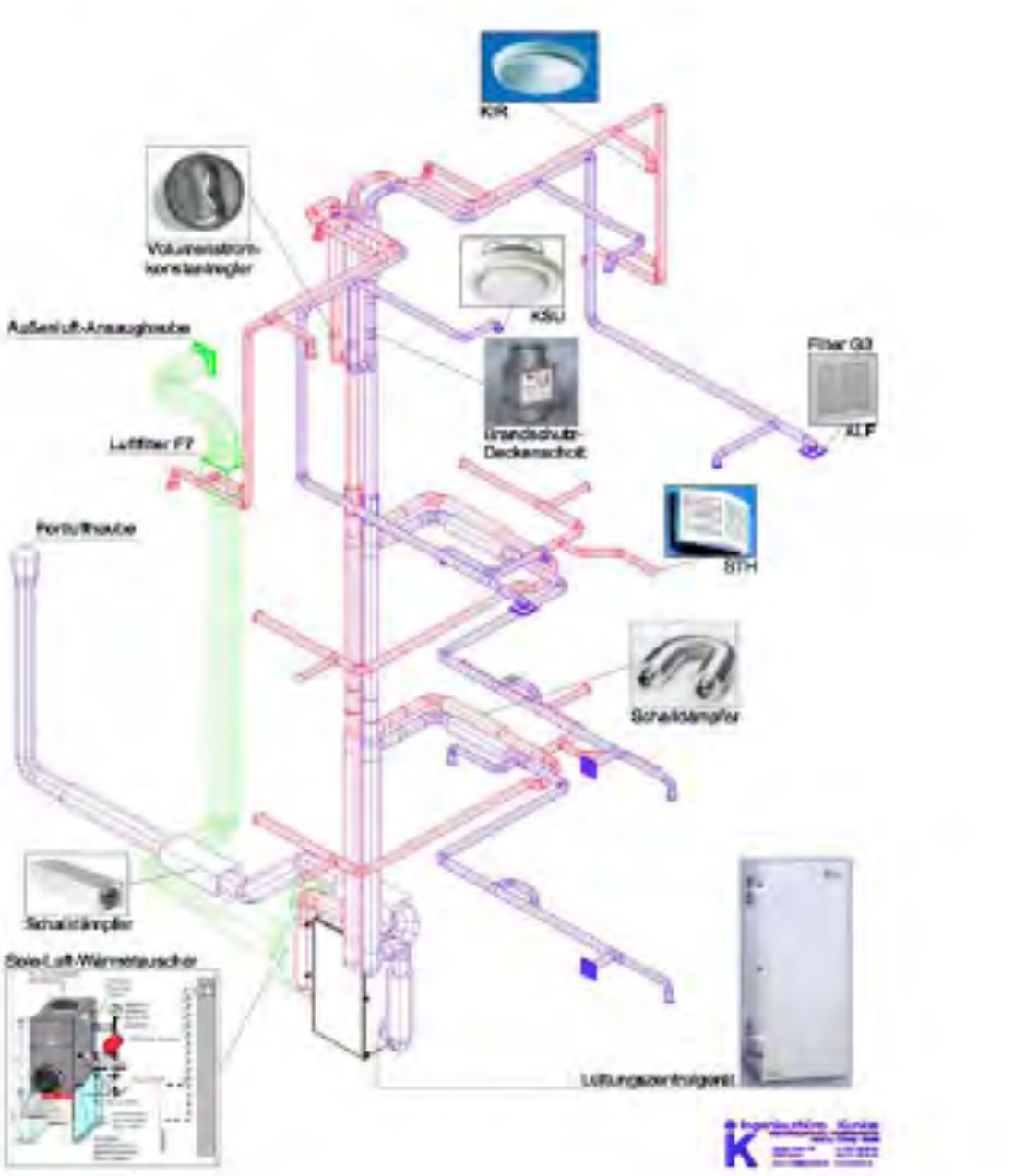
Multifamily Retrofit

View from the South

Multifamily Retrofit

Mechanical System:

- Ground source heat pump with 4 closed loop wells
- Solar thermal combined with storage supplemented by heat pmp
- Central ERV with smoke dampers preheated by hydronic piping around foundation perimeter
- Radiant floor heating
- Rainwater collection and storage
- Mechanicals integrated vertically into once was the latrine in the common hall



Multifamily Retrofit

Heatpump and ERV in tight spaces integrated vertically

Multifamily Retrofit

SHW with a ladder accessed from a skylight

Multifamily Retrofit

Living space: 430m² Occupancy:17 Persons p.a.

Annahmen:
Lüftung+RW-Pumpe 160 kwh/monatl.
Peisstand 01.01.2007 Stadtwerke Chemnitz AG

	Warm water pump	Electricity for heating, ventilation	Electricity house lighting	solar yield	Heating	Main water meter	Cold water	Warm water	Rain water	Regen-wasser Nach-speisung	Strom-preis WP	Strom-preis HZ+WW			Wichtung nach prozentualem kwh - Verbrauch incl.GG		Gesamtkosten Heizung, Trinkwasser-erwärmung, Steuerung, Heizstab pro m² Wfl
											Grund-gebühr €/ p.a.	Grund-gebühr in €/ p.a.	Heizung	Warm-wasser	Heizung	Warm-wasser	
	kwh	kwh	kwh	kwh	MWh	m³	m³	m³	m³	m³	€/kwh	€/kwh	kwh	kwh	€	€	€/m² Wfl
											0,1153	0,1968		2,0"V"40			
											43,80	35,40					
April 07	117	224	88	904	0,361	18	6,363	6,33	13,935	7,04	17,14	32,86	361,00	506,40	**20,81**	**29,19**	**0,1163**
Mai 07	5	164	82	600	0,095	16	5,486	8,339	12,619	2,17	4,23	19,87	95,00	667,12	**3,00**	**21,10**	**0,0560**
Juni 07	2	139	76	508	0	12	6,358	5,472	10,957	0,01	3,88	13,77	0,00	437,76	**0,00**	**17,65**	**0,0411**
Juli 07	0	131	68	150	0	11	5,956	4,88	11,092	0,03	3,65	10,63	0,00	390,40	**0,00**	**14,28**	**0,0332**
August 07	5	128	78	153	0	11	6,634	5,436	12,2	0,01	4,23	12,00	0,00	435,04	**0,00**	**16,23**	**0,0377**
September07	106	145	86	272	0,304	12	5,911	7,922	13,285	0,02	15,87	16,92	304,00	633,76	**10,63**	**22,16**	**0,0763**
Oktober 07	371	180	90	283	1,072	14	6,219	6,869	14,045	0,02	46,43	24,60	1.072,00	549,52	**46,95**	**24,07**	**0,1652**
November 07	832	183	96	52	2,386	14	6,538	7,576	14,18	0,04	99,58	26,37	2.386,00	606,08	**100,44**	**25,51**	**0,2929**
Dezember 07	871	195	68	65	2,451	13	6,208	8,345	13,14	0,04	104,08	23,22	2.451,00	667,60	**100,05**	**27,25**	**0,2960**
Januar 08	717	186	67	96	2,054	14	5,569	8,998	12,463	0,06	86,32	21,25	2.054,00	719,84	**79,66**	**27,92**	**0,2502**
Februar 08	576	171	56	204	1,793	14	5,285	8,93	12,474	0,04	70,06	16,14	1.793,00	714,40	**61,64**	**24,56**	**0,2005**
März 08	581	182	57	315	1,755	16	6,016	9,17	12,733	0,03	70,64	18,50	1.755,00	733,60	**62,86**	**26,28**	**0,2073**
April 08	288	182	64	503	1,01	14	6,56	8,97	13,06	0,06	36,86	19,87	1.010,00	717,60	**33,17**	**23,56**	**0,1319**
Mai 08	17	172	55	393	0,116	14	6,671	7,662	13,23	0,04	5,61	16,14	116,00	612,96	**3,46**	**18,29**	**0,0506**
Juni 08	0	173	60	775	0	15	6,185	6,277	10,246	1,11	3,65	17,32	0,00	502,16	**0,00**	**20,97**	**0,0488**
Juli 08	0	137	48	666	0	11	6,301	6,719	10,167	0,33	3,65	7,87	0,00	537,52	**0,00**	**11,52**	**0,0268**
August 08	2	151	56	165	0	18	8,014	8,471	12,837	2,41	3,88	12,20	0,00	677,68	**0,00**	**16,08**	**0,0374**
September08	129	173	60	-6369	0,297	14	6,288	7,363	12,096	0,07	18,52	17,32	297,00	589,04	**12,01**	**23,83**	**0,0833**
Oktober 08	340	180	61	237	0,727	-833	6,681	7,828	11,752	3,15	42,85	18,89	727,00	626,24	**33,17**	**28,57**	**0,1436**
November 08	640	191	66	70	1,873	17,28	7,09	8,643	12,414	2,44	77,44	22,04	1.873,00	691,44	**72,66**	**26,82**	**0,2314**

Multifamily Retrofit

Curious...

Multifamily Retrofit

Sills with exterior insulation