



# Monitoring the performance of renovated housing blocks in Hanover: first results



# Concerto multi-occupancy houses in Hanover



Housing society	object	flats	m <sup>2</sup>	standard	metering equipment	metering period
Gundlach	Ernst-Eiselenstr. 1, 3, 5	24	1524	EnEV new	Flowmeters (sum of heating and DHW) for heating station and in each flat	Heating station: monthly, flats: yearly
	Ernst-Eiselenstr. 2, 4, 6, 8	32	2032	EnEV new		
	Auf dem Hollen 15, 17, 19	24	1524	Kronsberg		
Spar- und Bauverein	Hirtenweg 18, 20, 22, 24	32	1900	EnEV new	Flowmeters for district heating (input) and heating energy (without DHW),	Heating station: monthly, flats: yearly
	Linsingenstr. 31, 31a, 31b	32	1975	EnEV new		
	Linsingenstr. 33, 35, 37	24	1184	EnEV new		
	Linsingenstr. 46, 46a-c	40	1832	EnEV new		

all objects: energetic refurbishment on high level (Insulation of walls, roofs, cellars, windows)

centralisation of heating: district heating (arithmetically from biomass)



# correction of energy consumption data



- ▶ correction of metering data per flat (partly inconsistent reading data)
  - ▶ year = begin of period
  - ▶ subtraction of gas cookers (450 kWh/a) and DHW (19 kWh/m<sup>2</sup>a), related to particular metering period (after renovation metering data, if possible)
  - ▶ calculation of total reduction in % and allocation to flats
  - ▶ correction of vacancy only for missing data
  - ▶ estimated efficiency factor for DHW final energy
- ▶ climate correction of the remaining amount
- ▶ comparison before-after renovation and with calculated results (PHPP)



## Gundlach

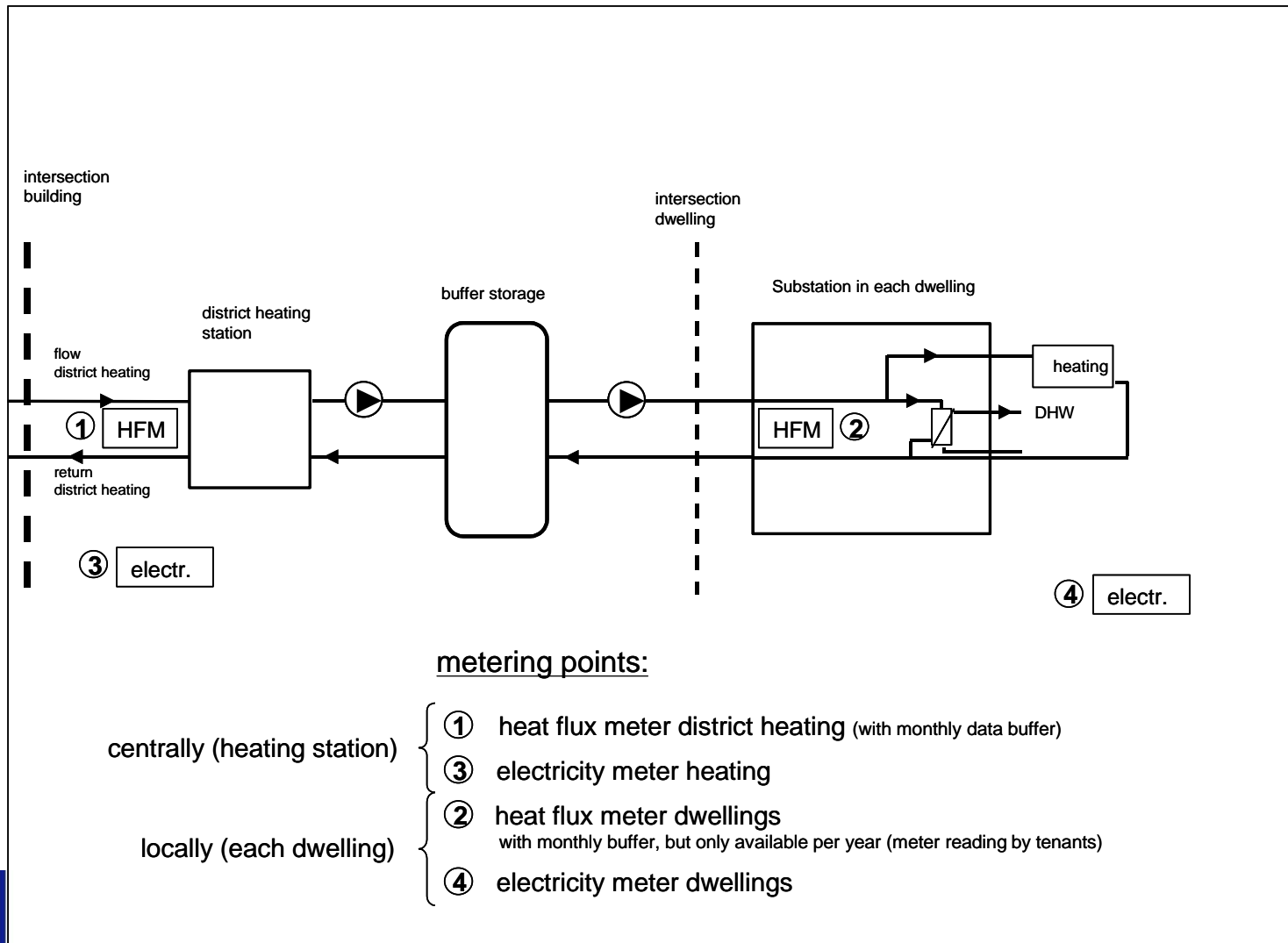
- ▶ flow meters for district heating and in each flat (Heating and DHW together)
- ▶ => monitoring for each flat possible
- ▶ district heating: per month, flats: only per year
- ▶ DHW to be calculated from summer months (incl. losses!)
- ▶ allocation of energy losses to heating and DHW?

## Spar- und Bauverein

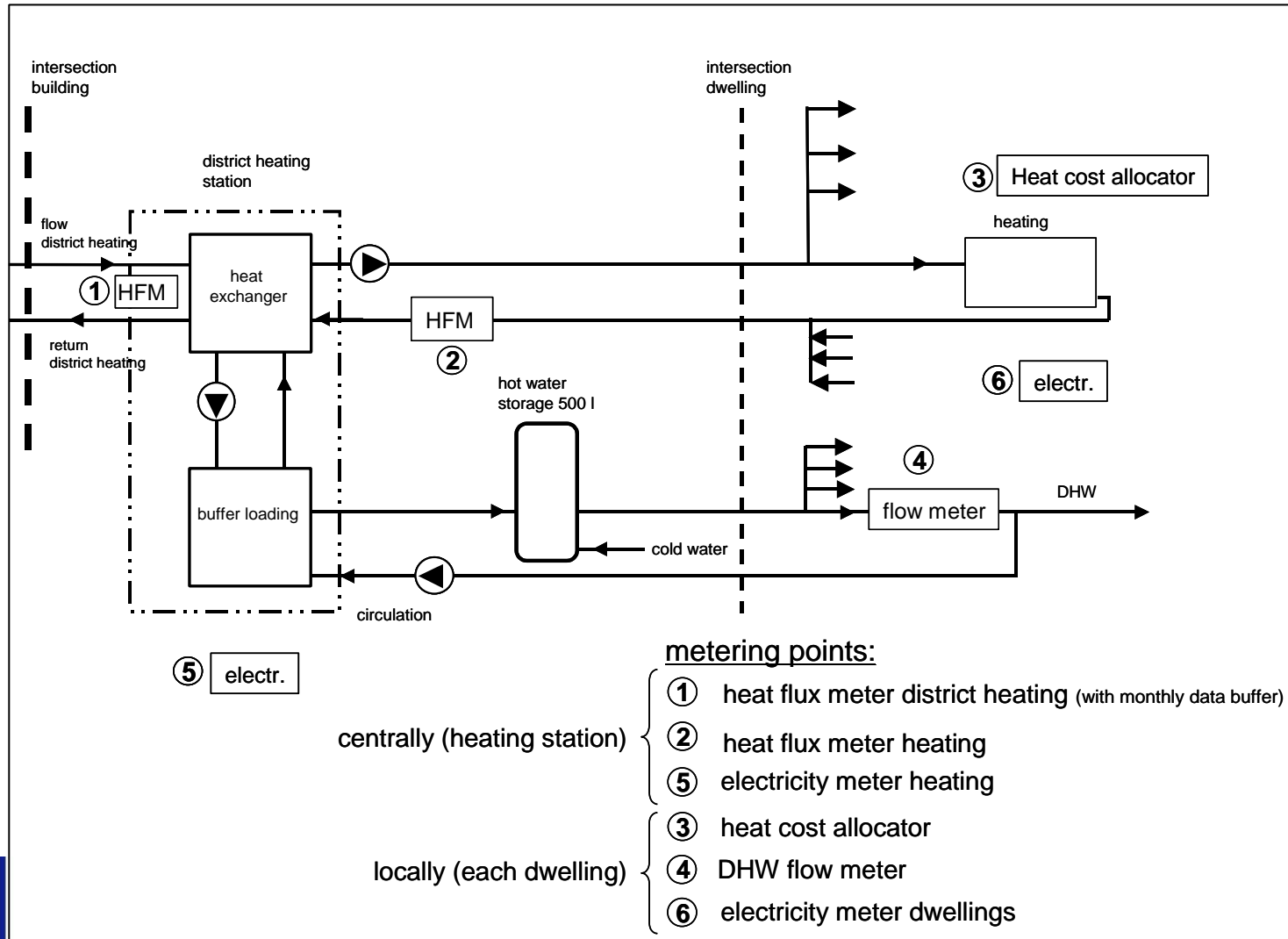
- ▶ flow meters for district heating and heating fraction
- ▶ (partly) data per month
- ▶ DHW (incl. losses) from meter difference



# heating supply scheme Gundlach



# heating supply scheme Spar+Bau



- ▶ all results refer to final energy
- ▶ results from heating period 2007-2008
  
- ▶ specific values are related to useful area (living space) acc. to German law
- ▶ all heating energy data are with climate correction to average climate of Hanover (1991-2000)



# first results 2007/2008 (Gundlach)



		Ernst-Eiselen-Str. 1, 3, 5				Ernst-Eiselen-Str. 2, 4, 6, 8				Auf dem Hollen 15, 17, 19			
		metered [kWh/m²a]		PHPP [kWh/m²a]		metered [kWh/m²a]		PHPP [kWh/m²a]		metered [kWh/m²a]		PHPP [kWh/m²a]	
<b>initial state</b>	heating	151	90%	159		110	85%	123		166	90%	163	
	DHW	17	10%	31		19	15%	29		19	10%	31	
	sum	168	100%	190		129	100%	152		185	100%	194	
<b>after retrofitting</b>	heating	<b>52</b>	62%	<b>42</b>		<b>39</b>	57%	<b>44</b>		<b>50</b>	62%	<b>42</b>	
	DHW	32	38%	15		29	43%	18		32	38%	17	
	sum	85	100%	57		68	100%	62		82	100%	59	
<b>energy savings</b>	heating	99	<b>65%</b>	117	<b>73%</b>	72	<b>65%</b>	79	<b>64%</b>	115	<b>70%</b>	121	<b>74%</b>
	DHW	-15	-90%	16	51%	-10	-53%	11	39%	-13	-66%	14	44%
	sum	84	<b>50%</b>	133	<b>70%</b>	62	<b>48%</b>	90	<b>59%</b>	103	<b>56%</b>	134	<b>69%</b>





# first results 2007/2008 (S&B)



		Linsingenstraße 31, 31a, 31b				Hirtenweg 18, 20, 22, 24			
		metered [kWh/m <sup>2</sup> a]		PHPP [kWh/m <sup>2</sup> a]		metered [kWh/m <sup>2</sup> a]		PHPP [kWh/m <sup>2</sup> a]	
<b>initial state</b>	heating	127	87%	127		137	88%	124	
	DHW	19	13%	18		19	12%	22	
	sum	146	100%	145		156	100%	146	
<b>after retrofitting</b>	heating	<b>63</b>	63%	<b>50</b>		<b>69</b>	68%	<b>56</b>	
	DHW	37	37%	25		32	32%	38	
	sum	99	100%	76		100	100%	94	
<b>energy savings</b>	heating	65	<b>51%</b>	77	<b>60%</b>	68	<b>50%</b>	68	<b>55%</b>
	DHW	-18	-92%	-7	-37%	-13	-66%	-17	-76%
	sum	47	<b>32%</b>	70	<b>48%</b>	55	<b>36%</b>	52	<b>35%</b>

		Linsingenstraße 33, 35, 37				Linsingenstraße 46, 46a, 46b, 46c			
		metered [kWh/m <sup>2</sup> a]		PHPP [kWh/m <sup>2</sup> a]		metered [kWh/m <sup>2</sup> a]		PHPP [kWh/m <sup>2</sup> a]	
<b>initial state</b>	heating	157	89%	160		141	88%	133	
	DHW	19	11%	25		19	12%	22	
	sum	176	100%	185		160	100%	155	
<b>after retrofitting</b>	heating	<b>75</b>	67%	<b>55</b>		<b>58</b>	56%	<b>58</b>	
	DHW	36	33%	43		46	44%	31	
	sum	111	100%	98		103	100%	89	
<b>energy savings</b>	heating	82	<b>52%</b>	105	<b>65%</b>	83	<b>59%</b>	74	<b>56%</b>
	DHW	-17	-91%	-18	-75%	-27	-141%	-9	-39%
	sum	65	<b>37%</b>	86	<b>47%</b>	57	<b>35%</b>	66	<b>42%</b>



# climate correction

	average	2006		2007		2008		2009	
1	557	666	120%	437	78%	456	82%	476	85%
2	497	536	108%	430	87%	444	89%	363	73%
3	453	554	122%	397	88%	467	103%	299	66%
4	318	337	106%	225	71%	352	111%	75	24%
5	180	152	84%	142	79%	145	81%	49	27%
6	98	74	75%	25	25%	57	58%	38	39%
7									
8									
9	148	13	9%	157	106%	176	119%		
10	324	170	53%	343	106%	297	92%		
11	451	344	76%	443	98%	415	92%		
12	546	421	77%	532	97%	559	102%		
01-12	100%	91%		88%		94%			
06-05	100%	74%		94%		77%			
09-08	100%	73%		95%		77%			



# comparison of the metered and calculated results



- ▶ The predicted heating energy savings as percentage have nearly been reached in reality, in two cases they even have slightly been exceeded.
- ▶ The energy consumption for DHW preparation in most objects was much higher than calculated.
  - ▶ The used software (PHPP) has been designed for new buildings, especially the heating systems and hot water production cannot adequately be modelled for existing buildings
  - ▶ The metering data mostly do not allow an accurate distinction between energy use for heating, hot water production or distribution losses.
- ▶ The calculated total savings of energy use haven't been reached. The metered specific energy use for heating and DHW was up to 50 % higher than predicted. Only a few objects nearly reach the calculated results.



- ▶ DHW consumption becomes more important
  - ▶ part of final energy: 15%  $\Rightarrow$  >30%
  - ▶ often no/uncomplete metering data
  - ▶ high influence for energy saving
  - ▶ rising influence of distribution losses
- ▶ higher energy saving and lower specific heating energy consumption in Gundlach buildings (slightly more ambitious measures)
- ▶ Differences between flats become less after refurbishment
- ▶ Results are still preliminary. First results of 2008/2009 show similar tendency, but still must be examined



# heating energy use [kWh/m<sup>2</sup>a] in different flats



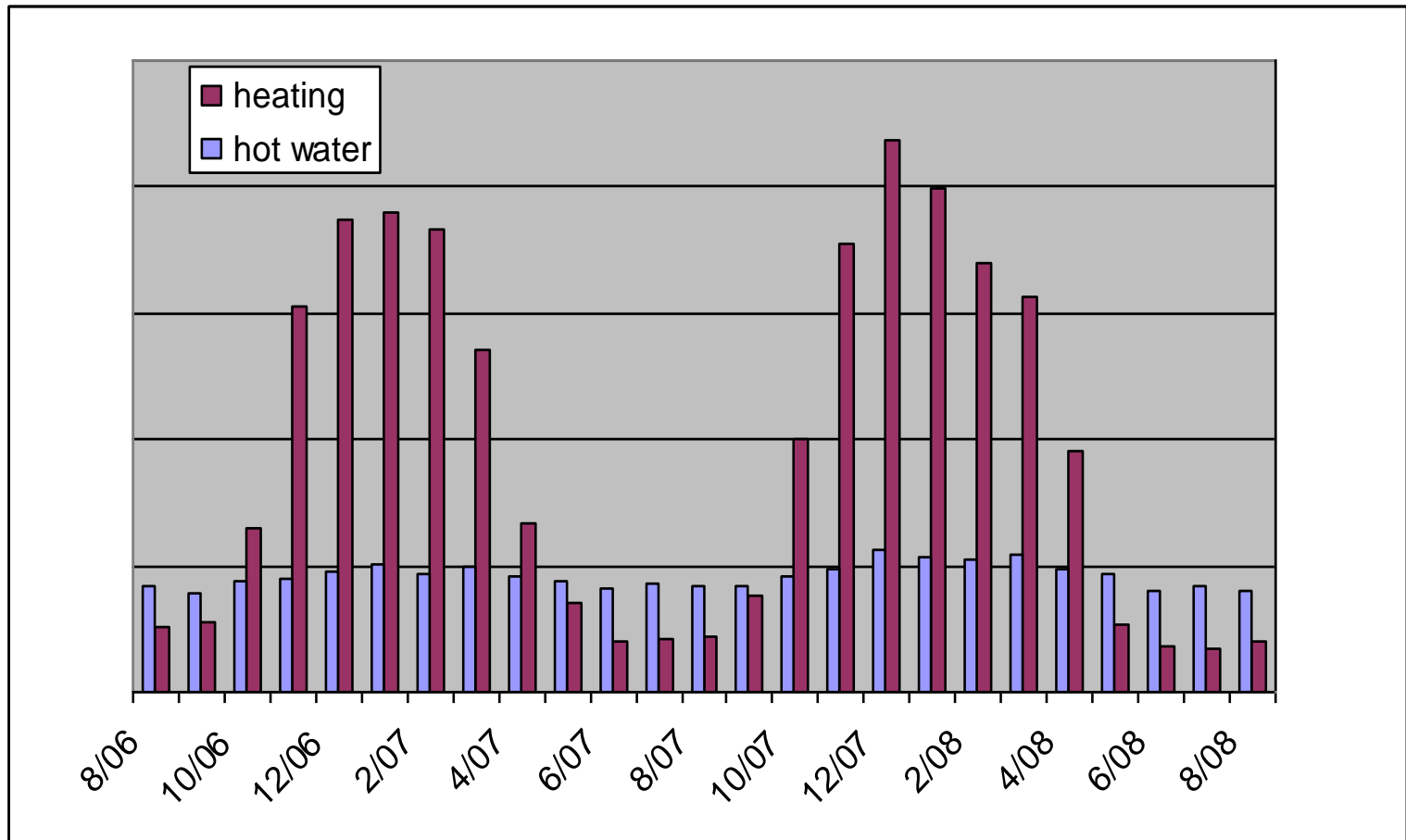
before retrofitting							average
3rd. floor	303	106	176	170	159	170	181
2nd. floor	192	172	149	147	69	152	147
1st. floor	126	134	116	199	53	164	132
pavement	232	183	178	157	438	98	214
average	213	149	155	168	180	146	168

after retrofitting							average
3rd. floor	32	22	43	54	54	56	43
2nd. floor	46	61	27	32	18	25	35
1st. floor	31	71	26	44	19	52	40
pavement	39	15	32	77	42	79	47
average	37	42	32	51	33	53	41



# energy use for heating and DHW

(Hirtenweg 24 after retrofitting, uncorrected values)



# Résumé



- ▶ The heating energy savings are not as high as predicted but much better compared to usual retrofitting measures.
- ▶ The slightly more ambitious measures in Gundlach buildings (e.g. minimisation of thermal bridges, new windows instead of changing only the glazing) lead to a higher energy saving and lower specific heating energy consumption than in the objects of Spar- und Bauverein.
- ▶ Regarding the DHW consumption the monitoring results so far don't allow a final assessment.
- ▶ Because of the minimisation of heating energy consumption the energy use for DHW preparation and distribution losses rises as a percentage. As a result the relevance of these aspects becomes more important after ambitious energetic retrofitting (optimisation potentials of further measure as well as the possible accuracy of monitoring)

