

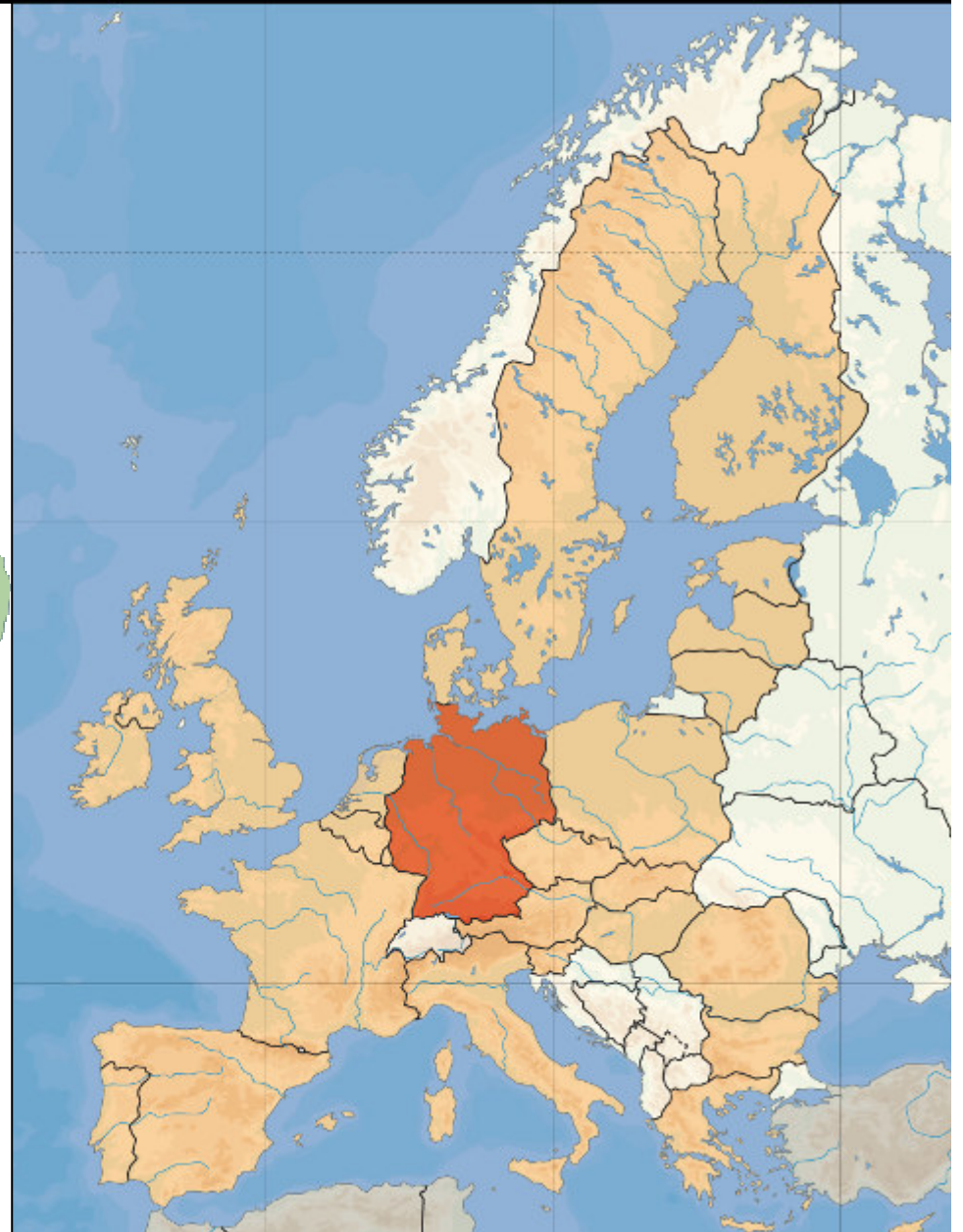


# Energy Management in Stuttgart

**Dr. Jürgen Görres**

**City of Stuttgart**

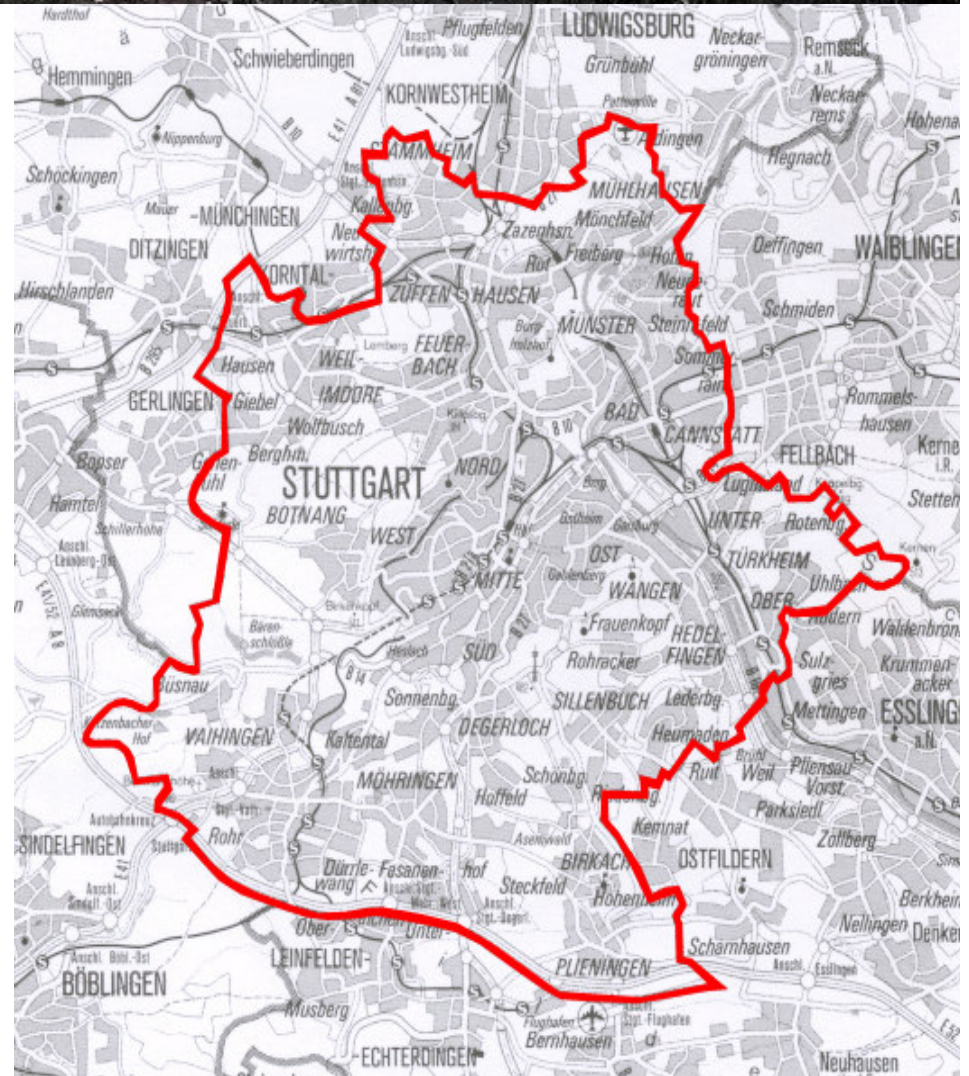
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# Stuttgart

- Capital of the state of Baden-Württemberg
- inhabitants: 590 000
- area: 207 km<sup>2</sup>
- elevation: 207 to 549 m above sea level
- Cold winter → heating
- Moderate summer → no cooling
- Temperature rise: 1.6 K in 3 decades





## Municipal energy consumption

- 1,427 buildings
- 2,188 other consumers e.g. streetlights, traffic lights, fountains

→ annual energy costs (2007):

power 23.5 Mio. Euro/a

heat 19.2 Mio. Euro/a

water 7.1 Mio. Euro/a

**total 49.8 Mio. Euro/a**



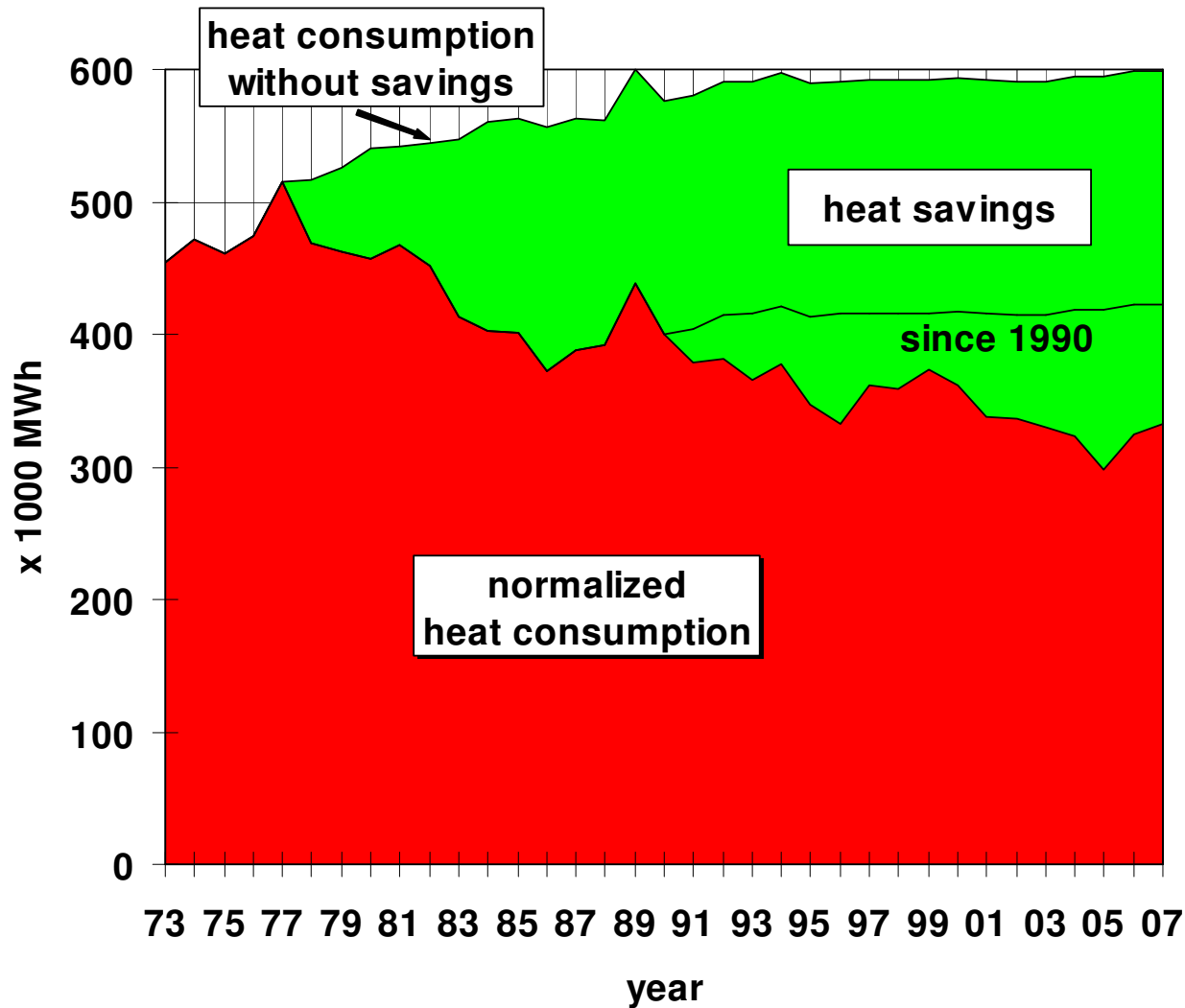
## Main tasks of the department for energy management

- surveying the energy and water consumption
- controlling energy bill
- consulting the caretakers, technicians and city council
- change the behaviour of the users
- developing guidelines
- purchasing energy
- research and demonstration projects
- public relations





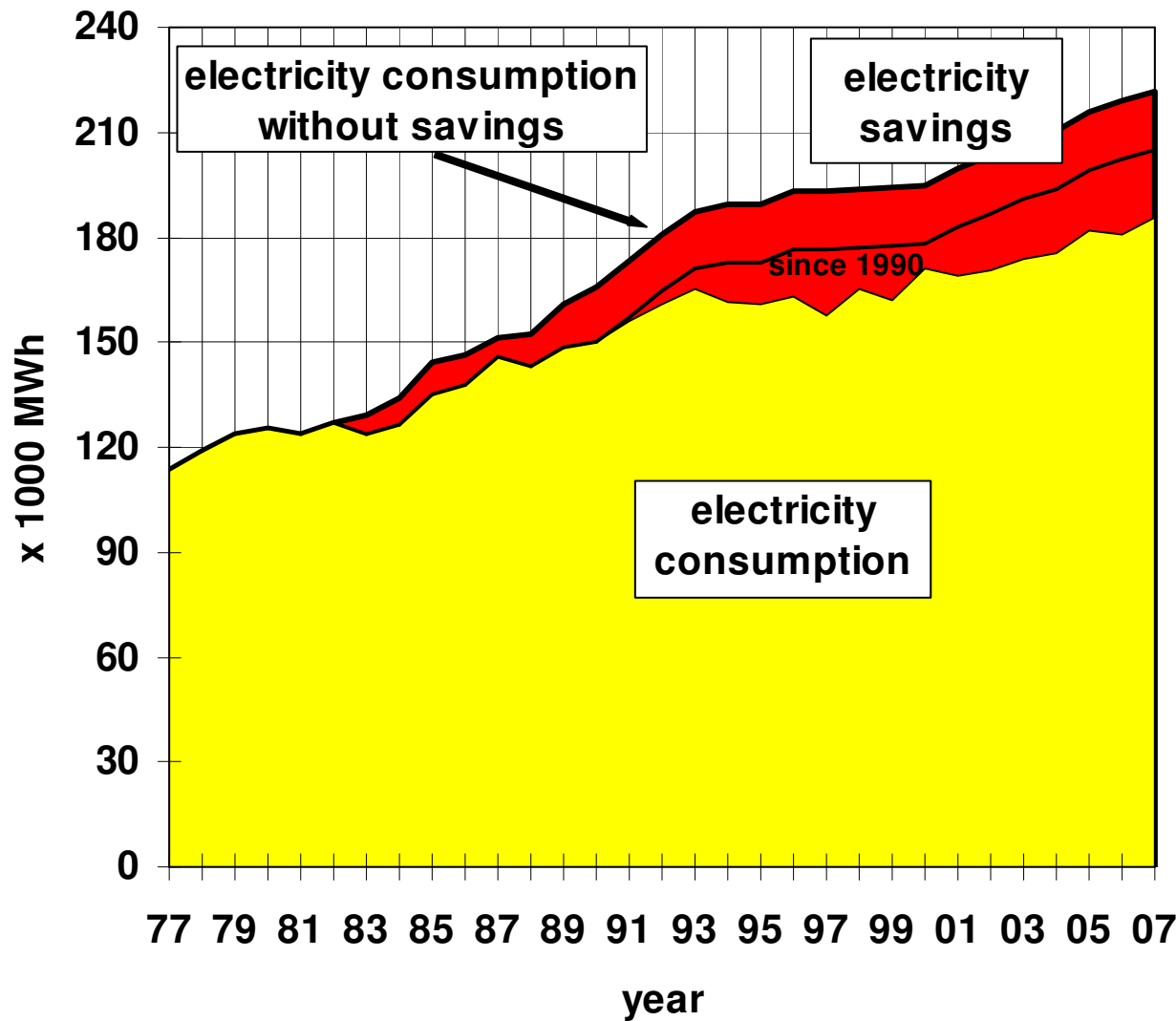
## Development of heat consumption



savings since 1977:  
5 826 239 MWh heat



## Development of electrical energy



savings since 1982:  
580,107 MWh



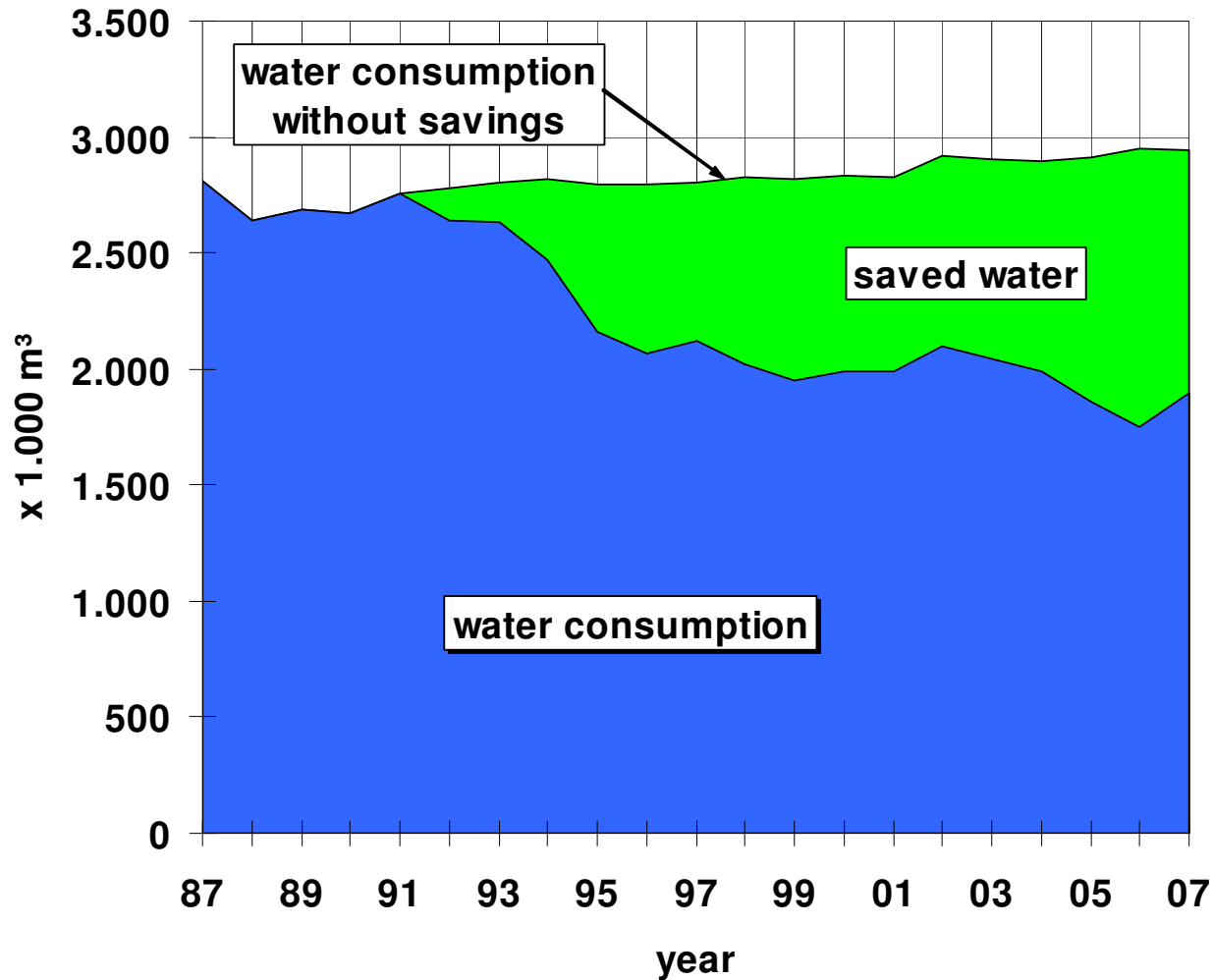
## Efficient use of electricity in Europe?







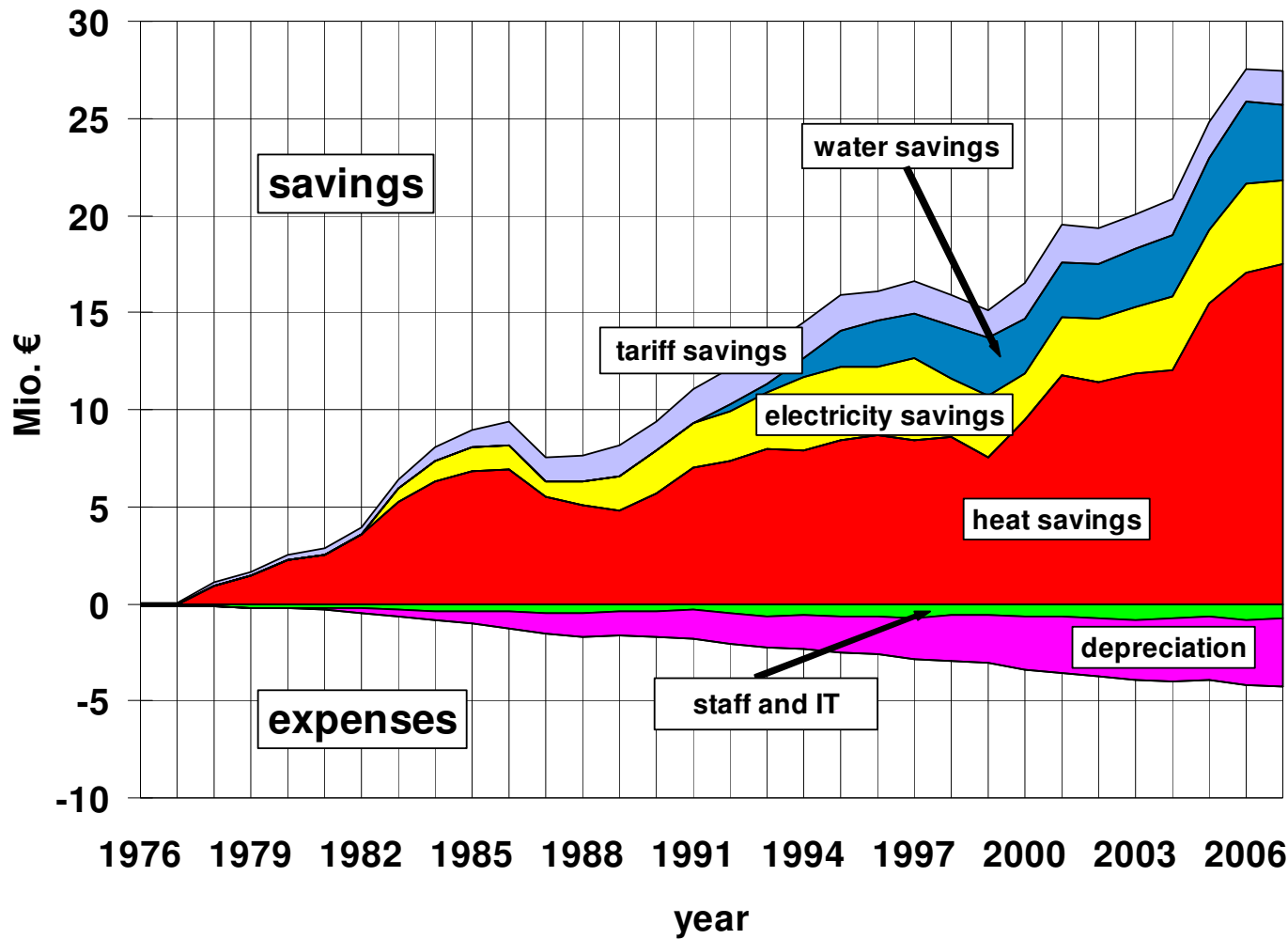
## Development of water consumption



savings since 1991:  
11,953,235 m<sup>3</sup>



## Savings versus expense for staff and investments



savings  
versus  
expenses:  
6.6 / 1



## Steps for Energy Efficiency

1. Guidelines for energy use
2. Analysis of all buildings (consumption, costs)
3. Optimizing operation
4. change of user behavior
5. measures for energy saving (new buildings and refurbishments)
6. renewable energies
7. Financing of energy saving investments
8. Publicity



# Step 1: Guidelines for energy use



## Compulsory energy instructions

- Responsibilities: Who deals with energy?
- Operating directives: Optimal parameter setting .
- instructions for staff: How, when energy is to be used.
- Monitoring of energy consumption
- Rules of behavior for municipal employees
- Documentation of operation and consumption
- Planning guidelines for design of new buildings: heating, ventilation, electricity, water

valid for all employees of the city of Stuttgart



## Key planning targets

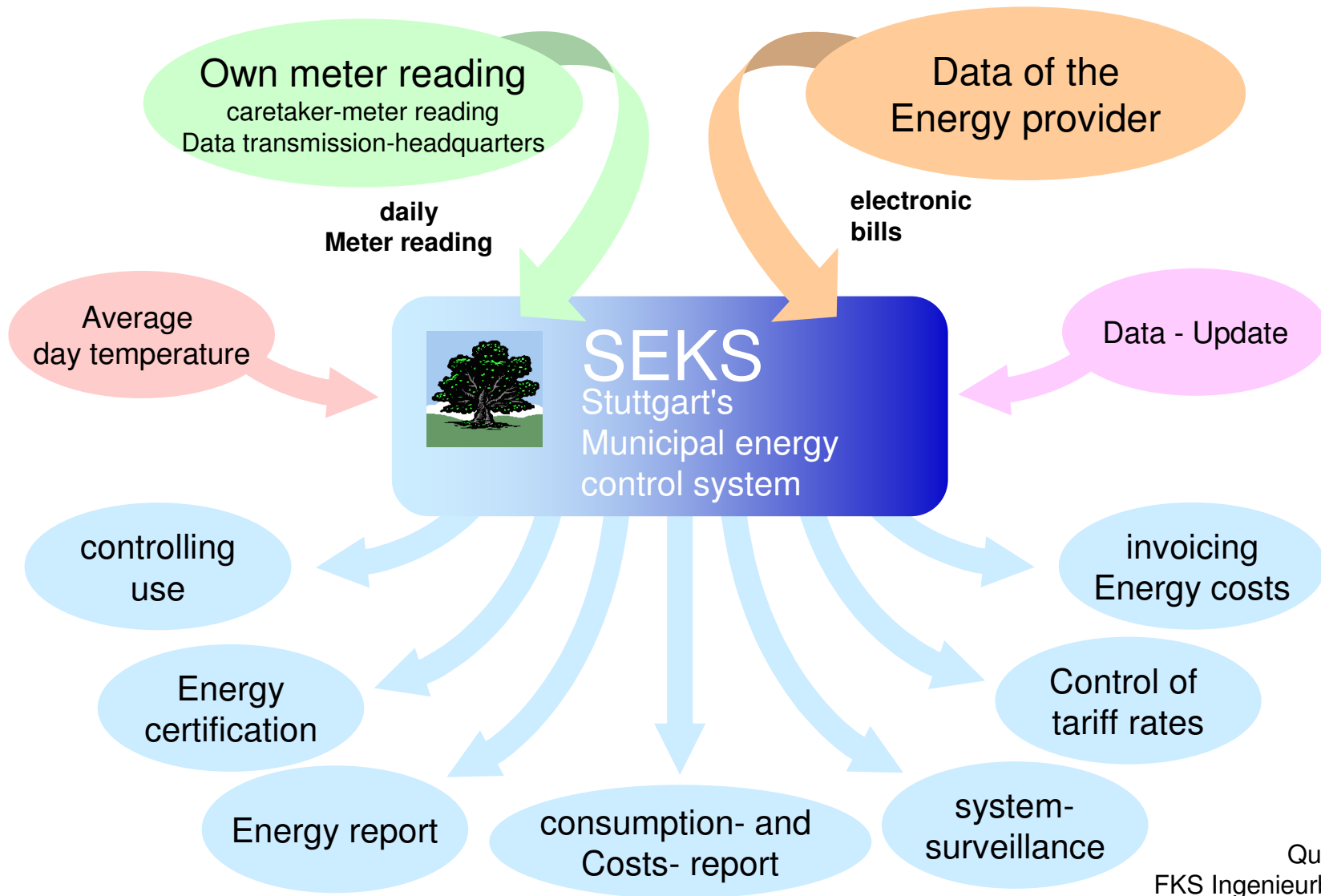
- **Improved energy standard 20% better than legal base**
- Good thermal insulation in winter and summer:  
→ Proportion of glass in façade < 35%,
- Heating system with low-temperature design (60/40 °C)
- Gas-fired condensing boilers or if possible combined heat and power
- Introduction of renewable energies: wood pellet, solar, heat pump,
- No air conditioning → unrestricted night ventilation,
- Natural Ventilation, (mechanical ventilation => WRG 70 % and 75 %)
- Lighting: high reflection factor of the surfaces, max. 2.5 W/m<sup>2</sup> per 100 lx, electrical ballast,



## **Step 2: Analysis of all buildings (consumption, costs)**



# Energy management system

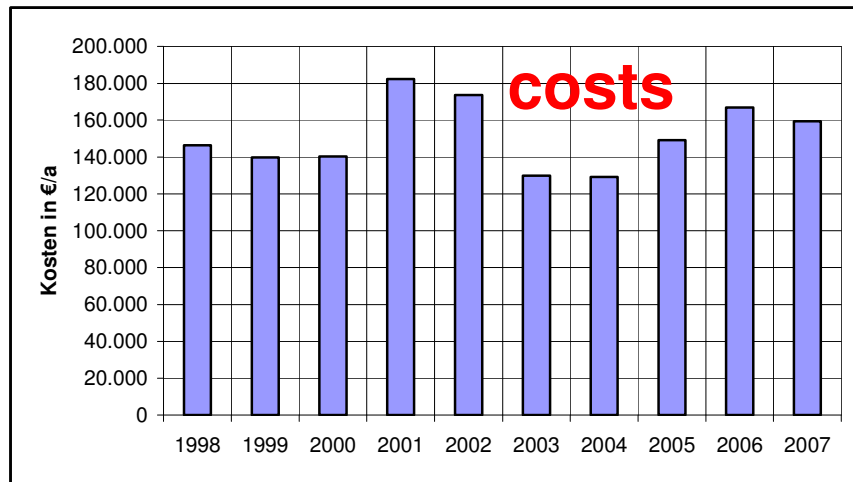


Quelle:  
FKS Ingenieurbüro



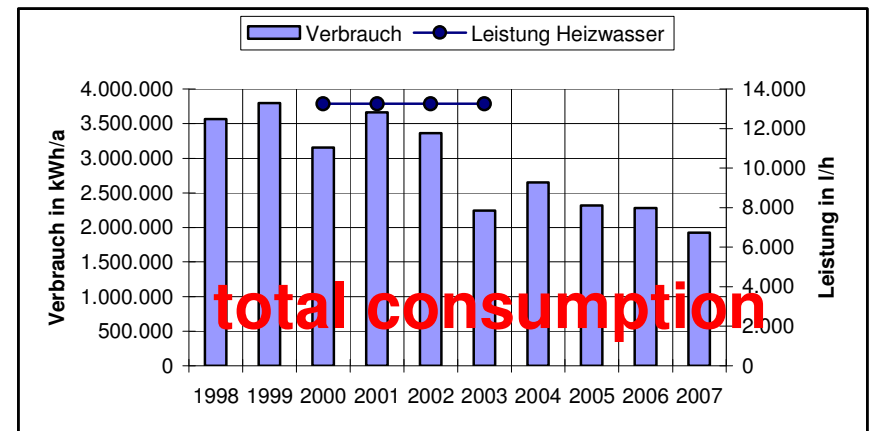
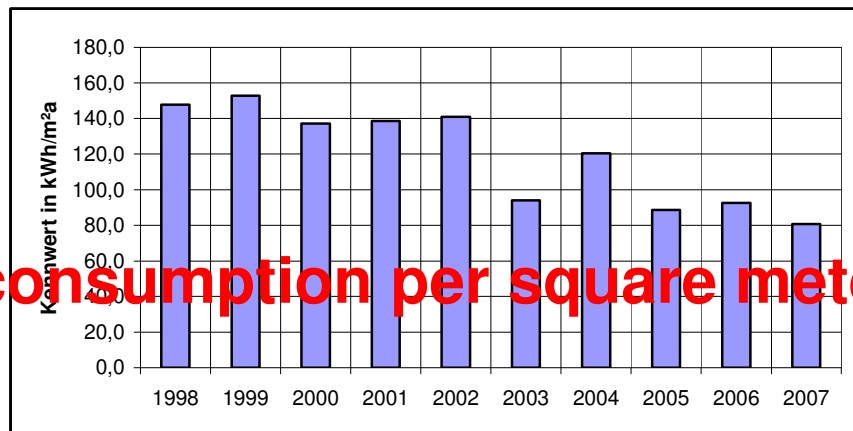


# Energy consumption of all buildings



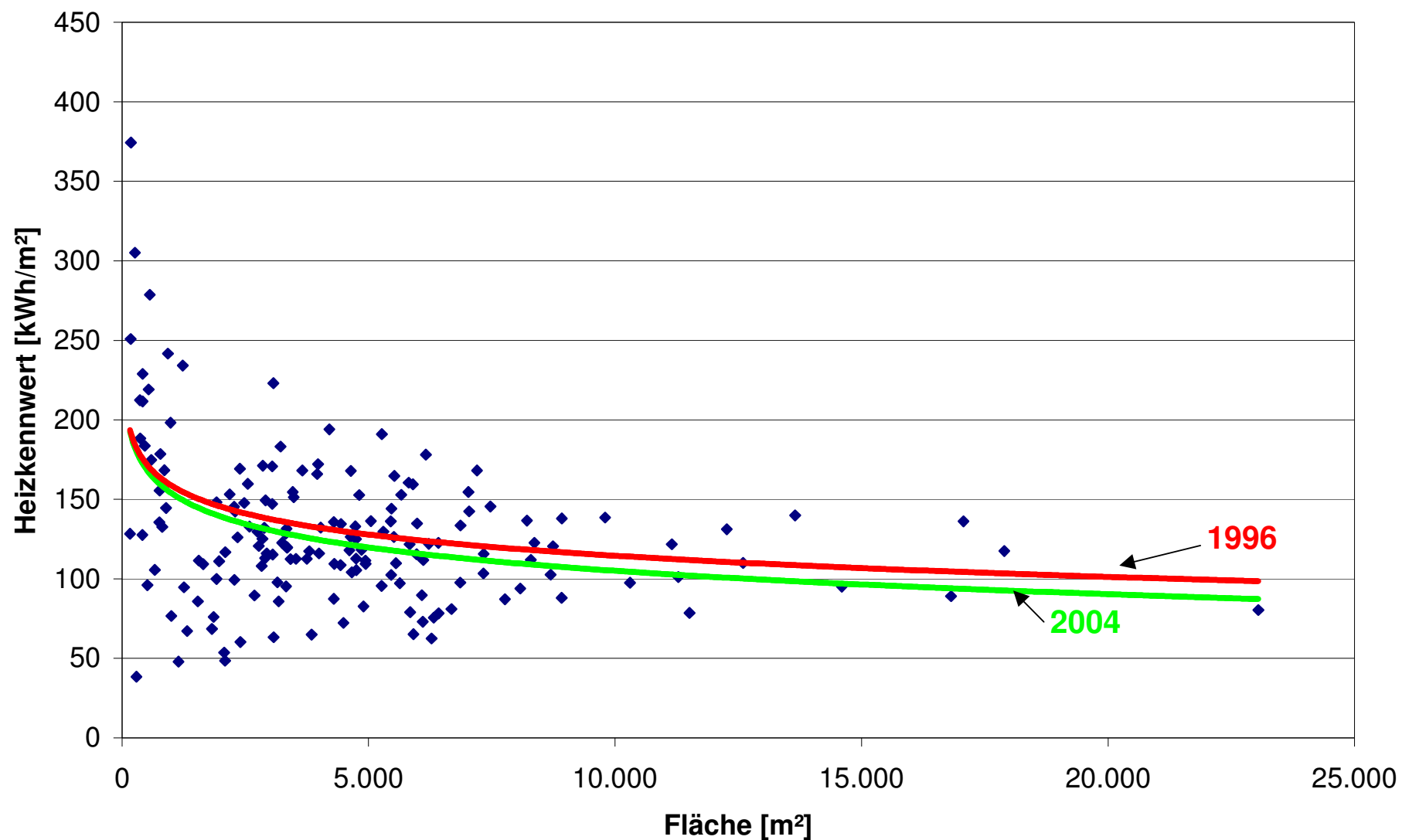
Jahr	Kennwert [kWh/m²a]	VJ¹ [%]	Verbrauch [kWh/a]	VJ¹ [%]	Kosten [€/a]	VJ¹ [%]	Leistung Heizwasser [l/h]	VJ¹ [%]
1998	147,8		3.564.391		146.431			
1999	152,8	3,4	3.796.357	6,5	139.735	-4,6		
2000	137,2	-10,2	3.156.524	-16,9	140.258	0,4	13.250	0,0
2001	138,6	1,0	3.664.101	16,1	182.368	30,0	13.250	0,0
2002	141,0	1,7	3.364.335	-8,2	173.552	-4,8	13.250	0,0
2003	94,0	-33,3	2.243.077	-33,3	129.883	-25,2	13.250	0,0
2004	120,4	28,1	2.648.897	18,1	129.128	-0,6		-100,0
2005	88,7	-26,3	2.315.820	-12,6	149.046	15,4		
2006	92,5	4,3	2.283.200	-1,4	166.746	11,9		
2007	80,8	-12,6	1.920.810	-15,9	159.301	-4,5		
Summen			28.957.512		1.516.448		5.300	
Mittelwert	119,4		2.895.751		151.645			
Änd. in %²	-45,3		-46,1		8,8			

¹ Prozentuale Veränderung im Vergleich zum Vorjahr  
² Veränderung vom ersten zum letzten Jahr





## characteristic value of all schools 2004



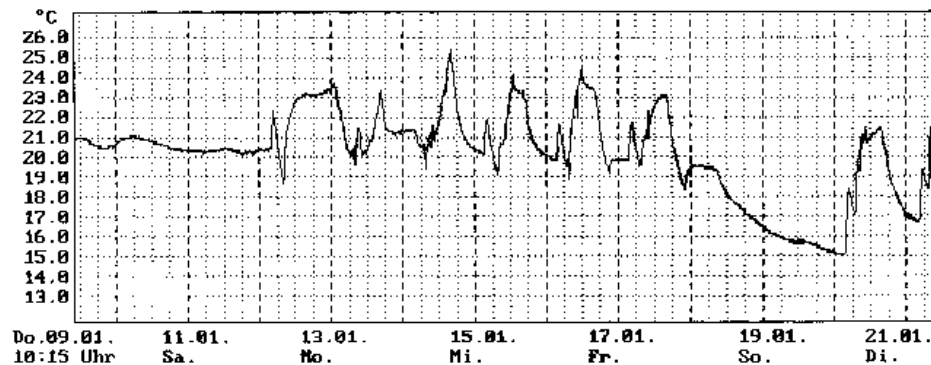


## Step 3: optimizing operation



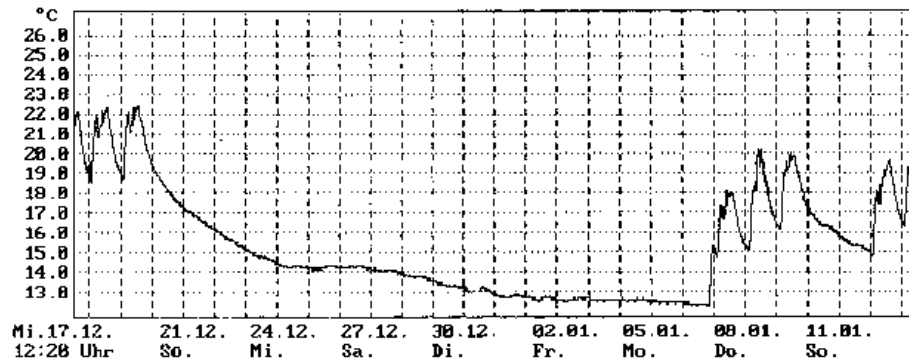
## Adjustment of control system

### Current situation



- Start-Stop Optimizing
- Annual programming e.g. for holidays
- heating curves adaptation
- Conjunction with boiler control

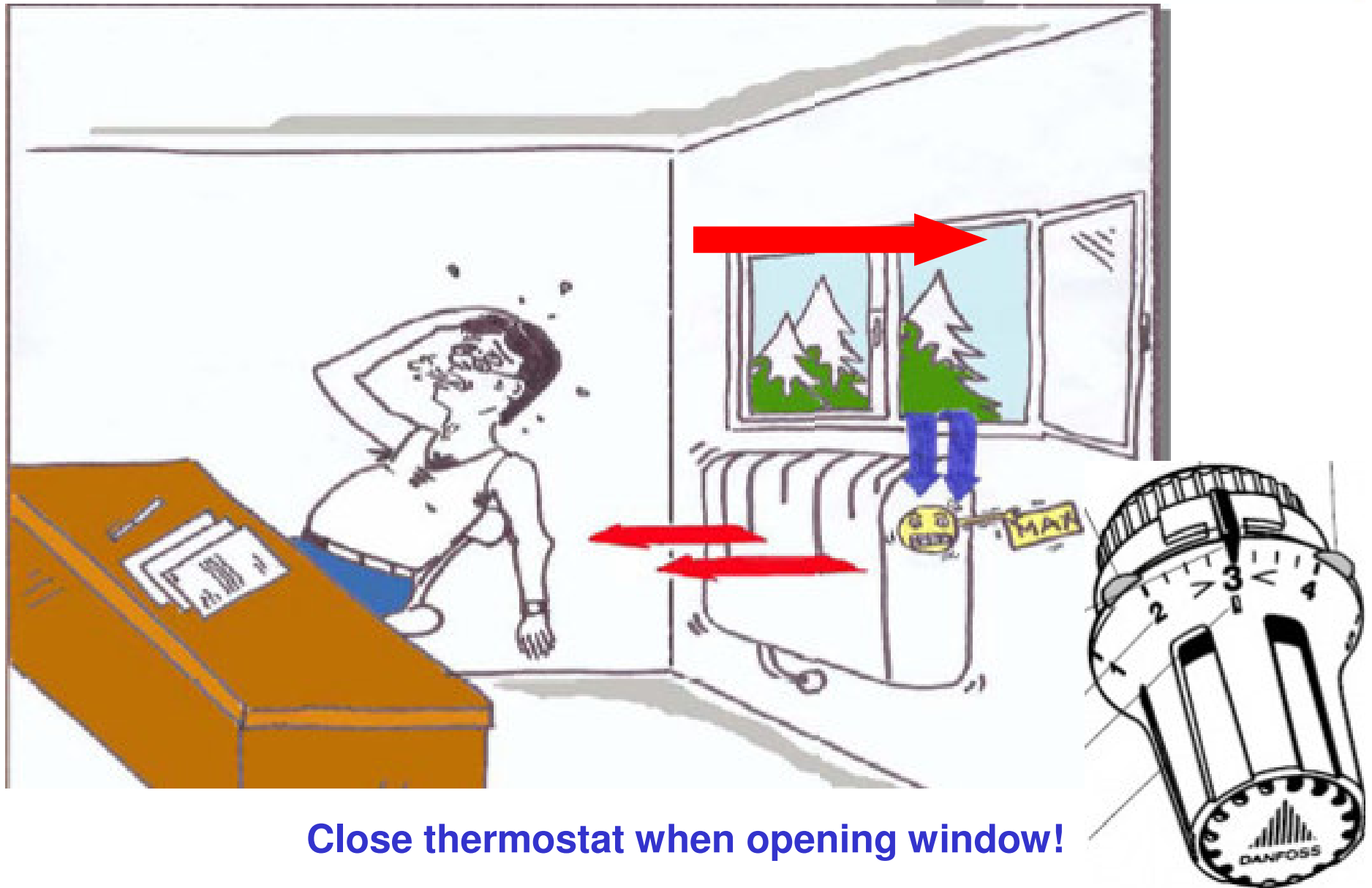
### Additional adjustment



Optimized appliances save energy !



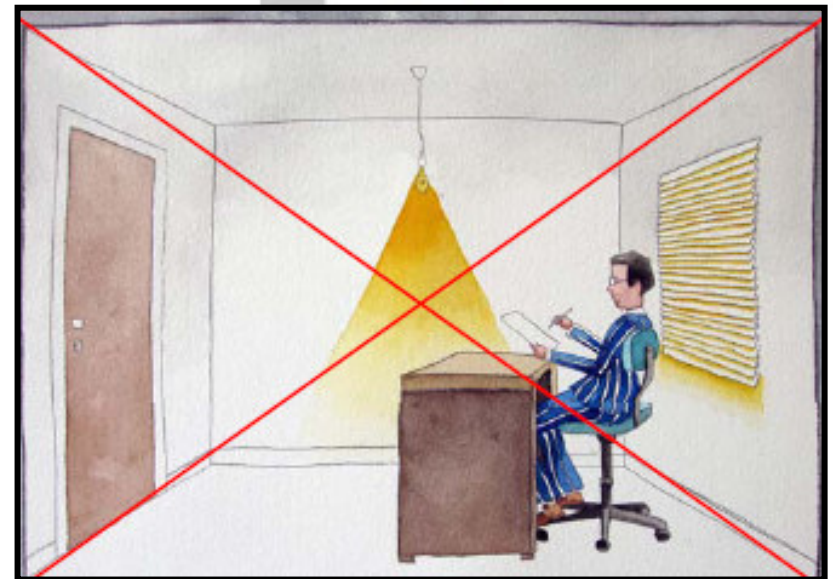
# Step 4: Change of user behavior



**Close thermostat when opening window!**



## heat protection in summer



[www.brita-in-pubs.eu](http://www.brita-in-pubs.eu)



## Switch off properly

**8 Watt Standby-losses  
per switched off computer**



Foto: Deutsche Energie-Agentur GmbH (dena)

multiple socket

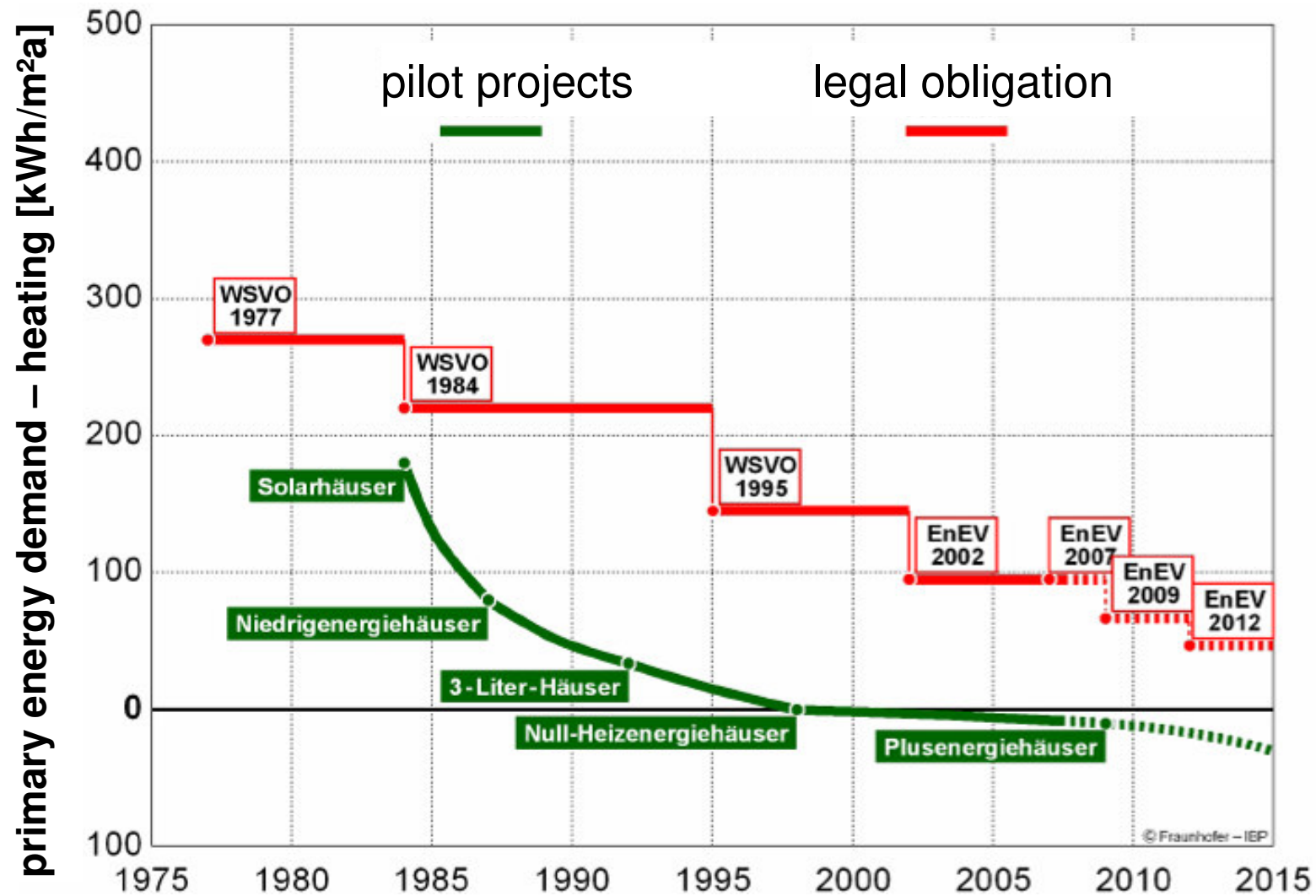




# Step 5: measures for energy saving



## energy efficiency of new buildings





## Improvement of housing stock



roof  $U = 0,15 \text{ W/m}^2 \text{ K}$

window  $U = 1,1 \text{ W/m}^2 \text{ K}$



top floor  $U = 0.2 \text{ W/m}^2 \text{ K}$



external wall  $U = 0,2 \text{ W/m}^2 \text{ K}$



cellar ceiling =  $0,4 \text{ W/m}^2 \text{ K}$



## Step 6: renewable energies



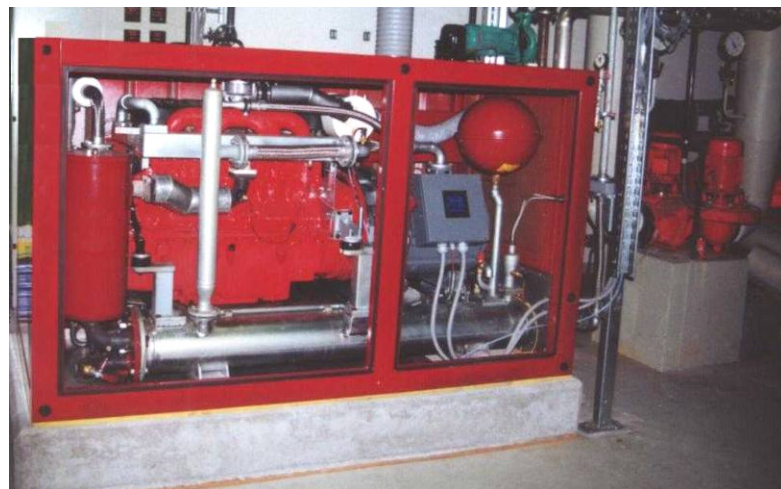
## Renewable energies



wood firings with own wood



solar thermal system  
solar absorber for public pools  
photovoltaic plants



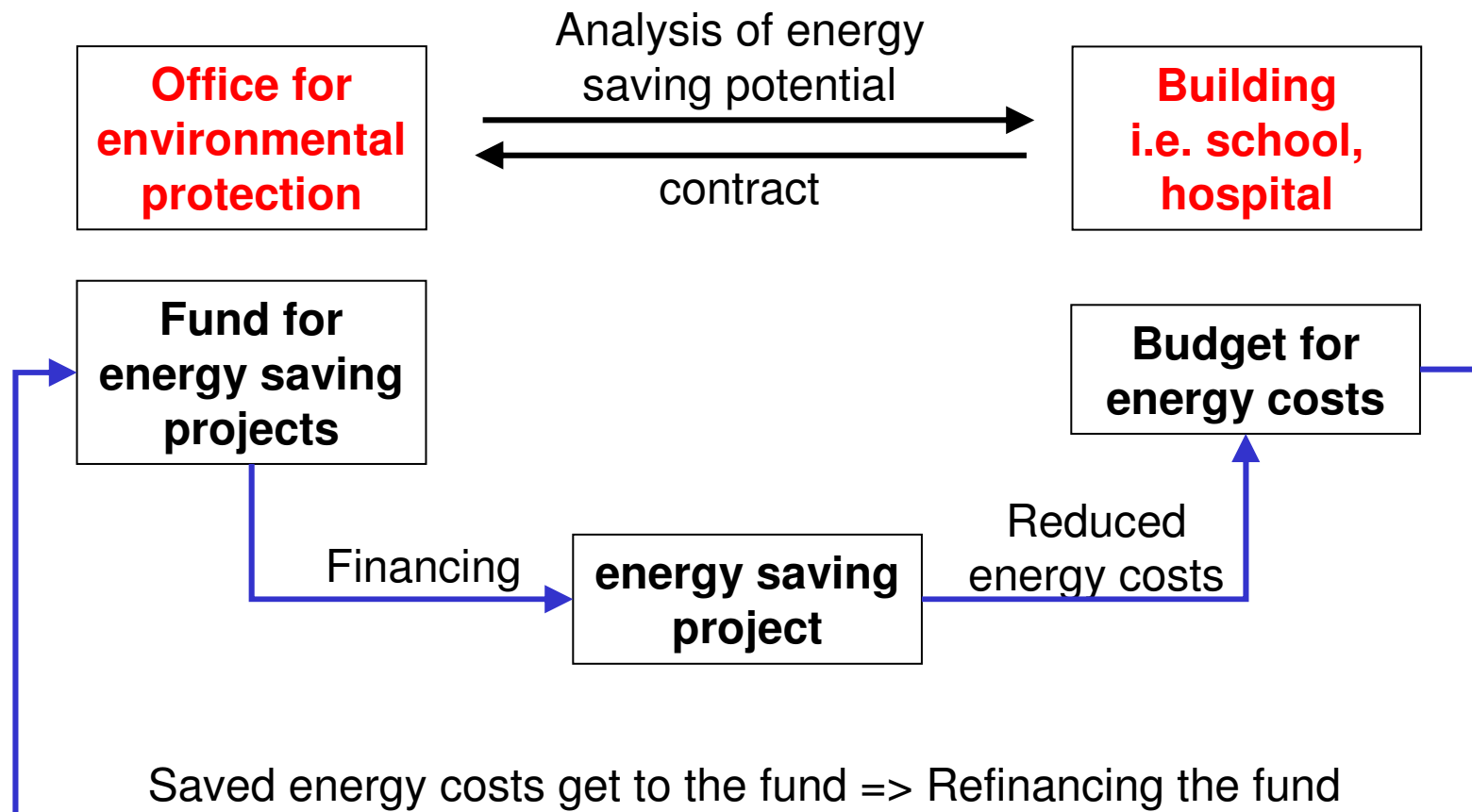
geothermal heat  
combined heat and power plants  
with sewage gas and natural gas



# Step 7: Financing of investments



## The principle of internal contracting





## 8. Publicity





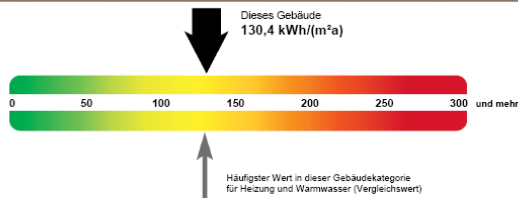
# Information

## ENERGIEAUSWEIS

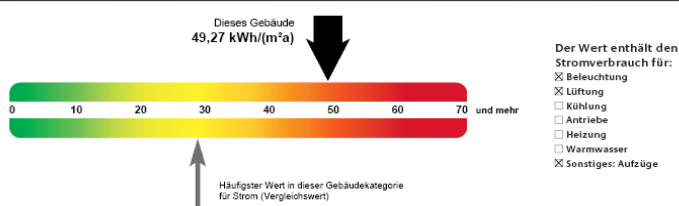
für Nichtwohngebäude

Erstellt am: 19.12.2005

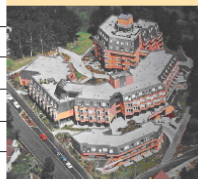
### Heizenergieverbrauchskennwert (einschließlich Warmwasser)



### Stromverbrauchskennwert



Gebäudekategorie	Betreuungseinrichtung
Sonderzone	
Adresse	Hans-Rehn-Stift
Baujahr Gebäude	1977
Baujahr Anlagentechnik	1977
Nettogrundfläche	13800 m <sup>2</sup>



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Landeshauptstadt Stuttgart  
Gaisburgstr.4  
70182 Stuttgart

Unterschrift Aussteller





# Thank You for Your attention

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# Step 8: Pilot Project / Research

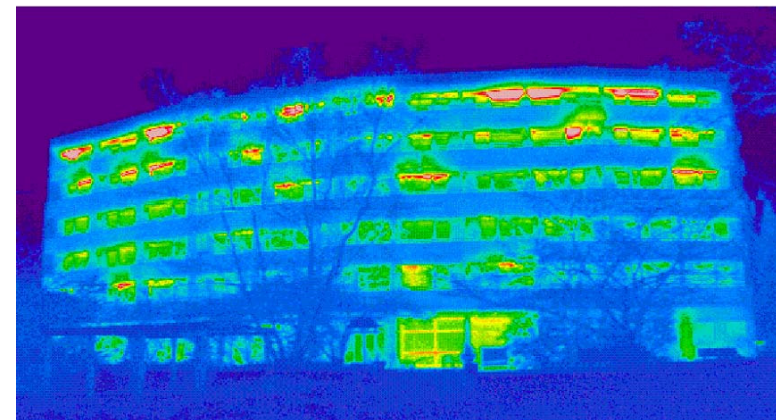


## CareRes – Retrofitting a retirement home



Energy retrofit of the whole building envelope and the technical systems

reducing the primary energy demand by **1.77 MWh/a** and the CO<sub>2</sub>-Emissions by **400 t/a**

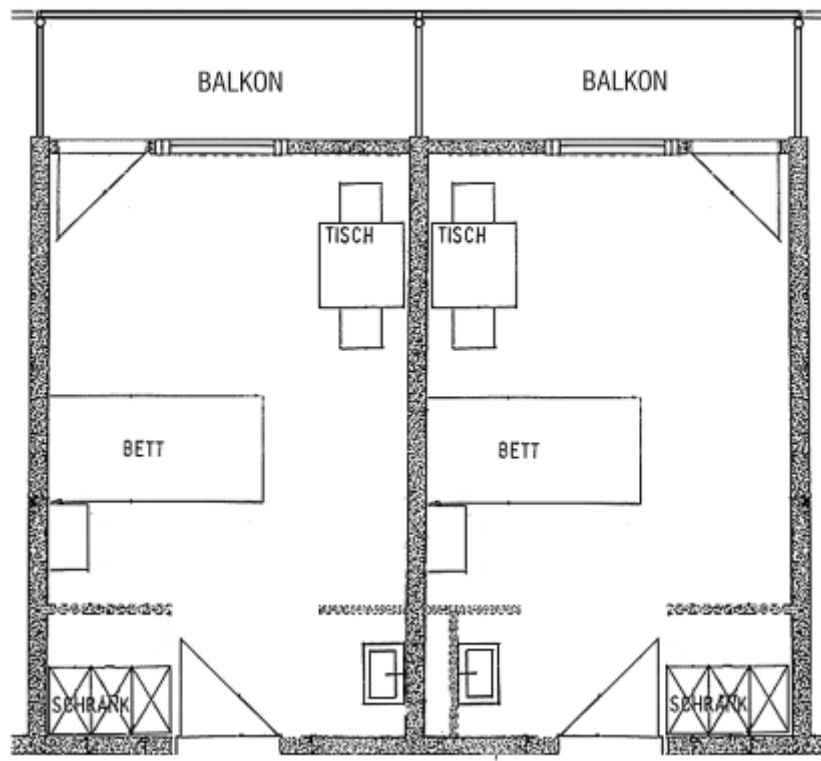


thermal bridges

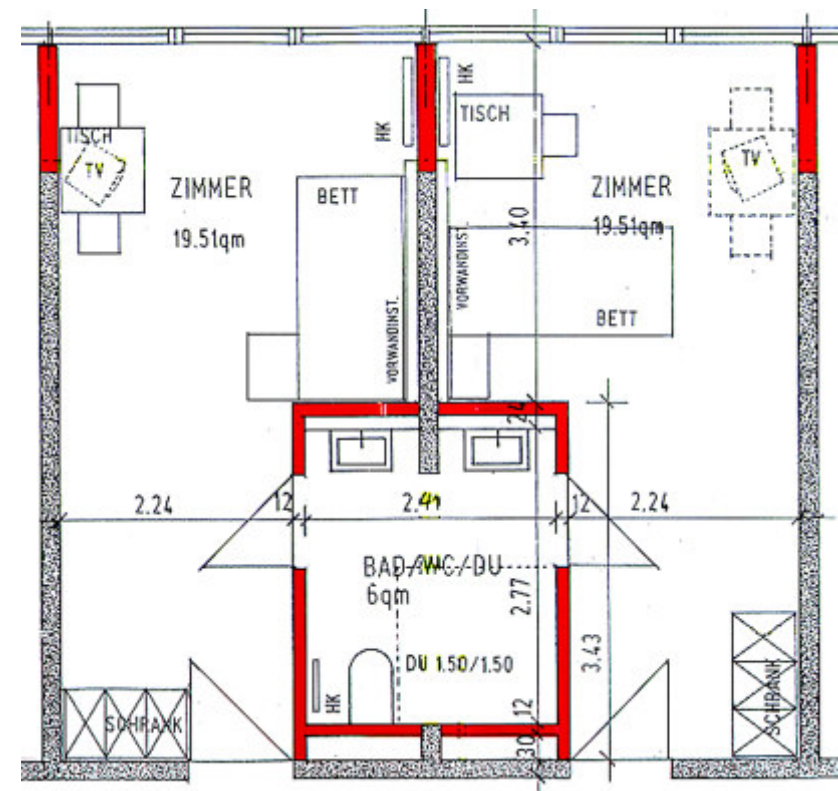


## rooms of the residents

before



after







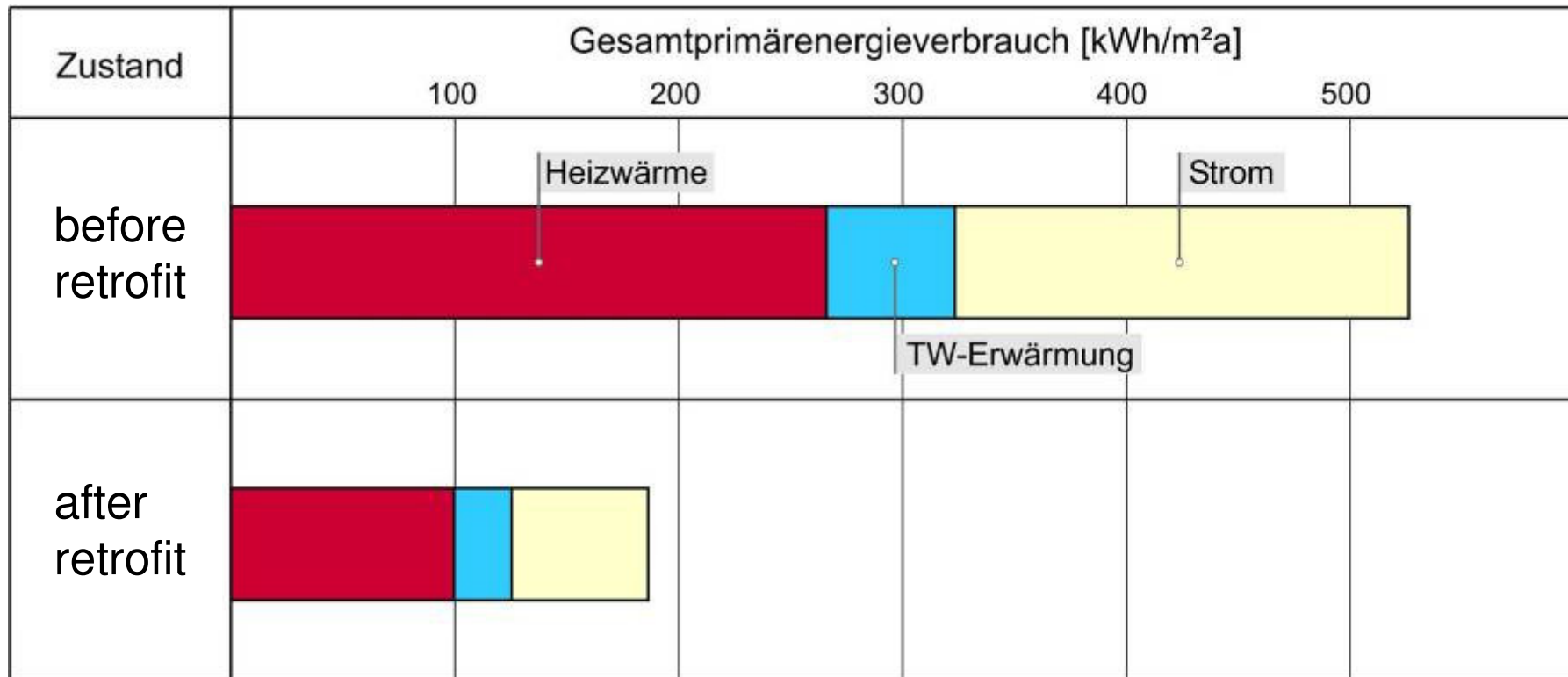
## Combined heat and power plants



- 35 - 52 kW electrical power
- 70 - 101 kW thermal power
- 91 - 99 % efficiency
- 254.000 kWh electricity/a
- 495.000 kWh heat/a
- 108.000 kg CO<sub>2</sub> - savings/a
- 16.000 € cost savings/a
- 90.000 € investment



## Primary energy demand



**reduction of 75 %**