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# POLYCITY

## Benchmarking – definitions and parameters

$\text{€} / \text{m}^2$ 

 $\text{m}^3 / \text{m}^2$ 



 European Committee for Standardization  
 Comité Européen de Normalisation  
 Europäisches Komitee für Normung


 International Organization for Standardization

$\text{CO}_2 / \text{m}^2$ 

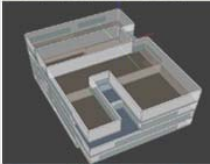

$\text{kWh} / \text{m}^2$

Polycity - meeting

Basel, 02 + 03 February 2006

U. Eicker / F. Hettler

Stuttgart University of Applied Sciences



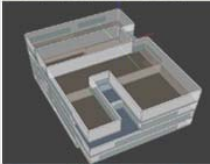
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# Indicators for buildings

## Examples:

- Heat: kWh / m<sup>2</sup>
- Cold: kWh / m<sup>2</sup>
- Electricity:
  - lighting kWh / m<sup>2</sup>
  - HVAC engineering kWh / m<sup>2</sup>
  - other applications kWh / m<sup>2</sup>
- Water: m<sup>3</sup> / m<sup>2</sup>
- Costs: € / m<sup>2</sup>
- Emissions: kg CO<sup>2</sup> / m<sup>2</sup>



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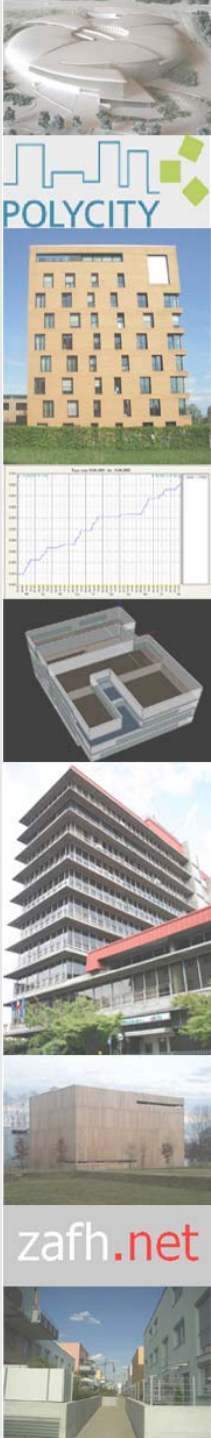


# Indicators for buildings

## Examples:

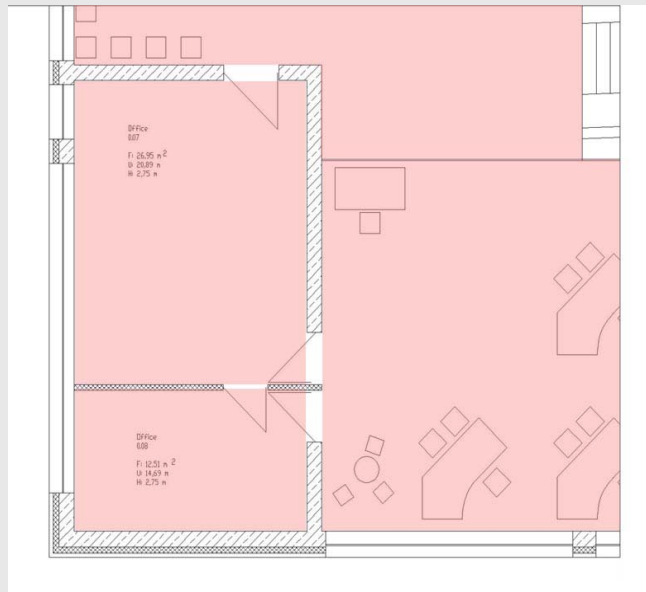
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→ WHAT MEANS m<sup>2</sup> ???

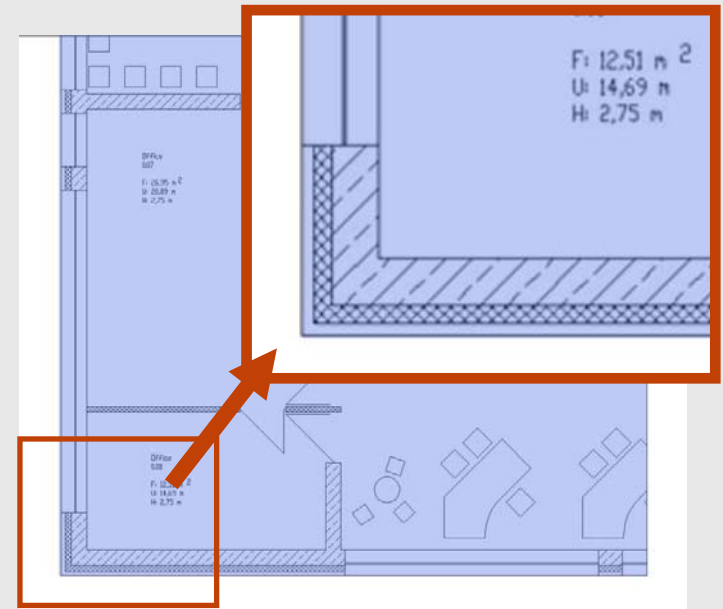


# m<sup>2</sup> - main definitions (DIN 277, V-DIN 18599, VDI 3807, EN 832)

- Living area „net“
- Total floor area „gross“



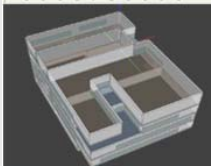
DIN18599



POLYCITY contract !

VDI 3807-1

→ Notice which m<sup>2</sup>-definition you are relating your indicators !



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# Indicators

Table 1. Conversion factors for calculating the gross ground area

| Type of building            | HNF<br>%         | NF<br>% | NGF<br>% | WF<br>% | BGF<br>% |
|-----------------------------|------------------|---------|----------|---------|----------|
| General educational schools |                  |         |          |         |          |
| Primary schools             | 59               | 66      | 89       |         | 100      |
| Grammar schools             |                  | 54      |          |         | 100      |
| Vocational schools          |                  | 62      |          |         | 100      |
| Administrative buildings    | 48               | 61      | 87       |         | 100      |
| Old-peoples' homes          | 43               | 60      | 87       |         | 100      |
| Day nurseries               |                  | 62      |          |         | 100      |
| Library buildings           |                  | 54      |          |         | 100      |
| Sports halls                |                  | 68      |          |         | 100      |
| One-/two-family houses      |                  |         |          | 71      | 100      |
| Apartment building          |                  |         |          | 59      | 100      |
| Warehouses                  | 66 <sup>*)</sup> |         |          |         | 100      |

\*) VKF = Sales area

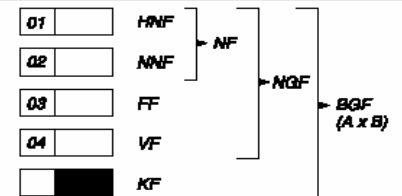
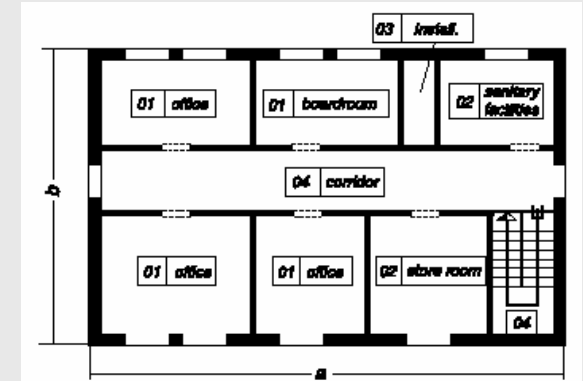


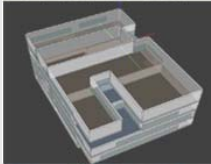
Fig. 1. Arrangement of areas according to DIN 277-1 and storey designations

- NF Occupied area
- HNF Main occupied area
- NNF Secondary occupied area
- FF Functional area
- VF Traffic area
- KF Structural area
- NGF Nett ground area
- BGF Gross ground area
- WF Living area
- VKF Sales area

VDI 3807-3

Alternative:

Volume m<sup>3</sup> includes heights  
 (high rooms need more energy).  
 → Always use gross volume !

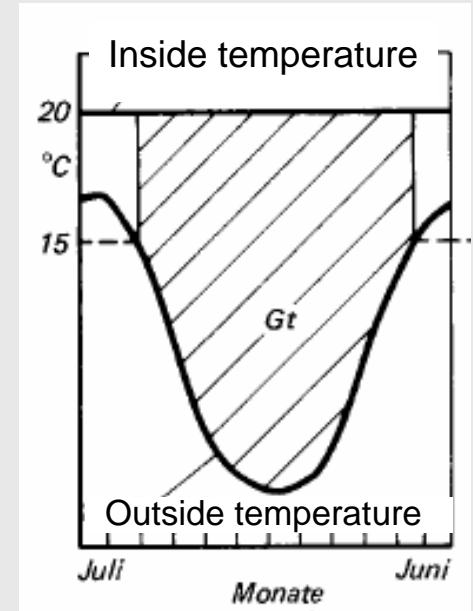


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# Compensation of indicators

- Standard: Outside temperature compensation of heat consumption degree-days
- POLYCITY contract:
  - D: 3079 degree days (20°C)
  - I: 2617 degree days (20°C)
  - ES: 401-800 degree days (Zone B)



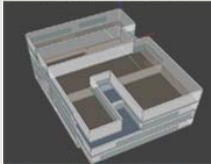
VDI 3807-2

| Required internal temperature (°C) | 22   | 21   | 20   | 19   | 18   | 17   | 16   | 15   | 14   | 13   | 12   | 11   | 10   |
|------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Degree day correction factor       | 1.29 | 1.19 | 1.09 | 1.00 | 0.91 | 0.82 | 0.73 | 0.65 | 0.57 | 0.50 | 0.43 | 0.37 | 0.31 |

Table A2.1 Factors for adjusting degree days to different base temperatures

[www.industrialbuildingsbenchmark.info](http://www.industrialbuildingsbenchmark.info)

- Other influence: solar irradiance!



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# Definition benchmarking

Benchmarking:


„To go for the best of the best“.

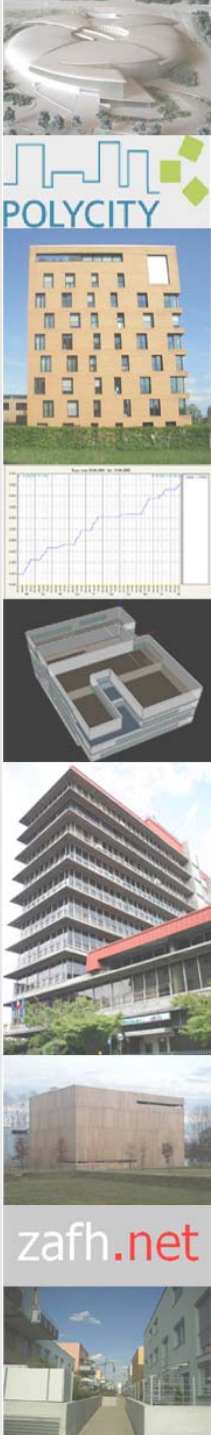
„Searching and finding of best practise examples and implementation of the concepts in one´s own company“.

(Bob Camp; Xerox Coop.)

Benchmarking in buidlings:

comparison of own consumption with other similar best-practise buildings.

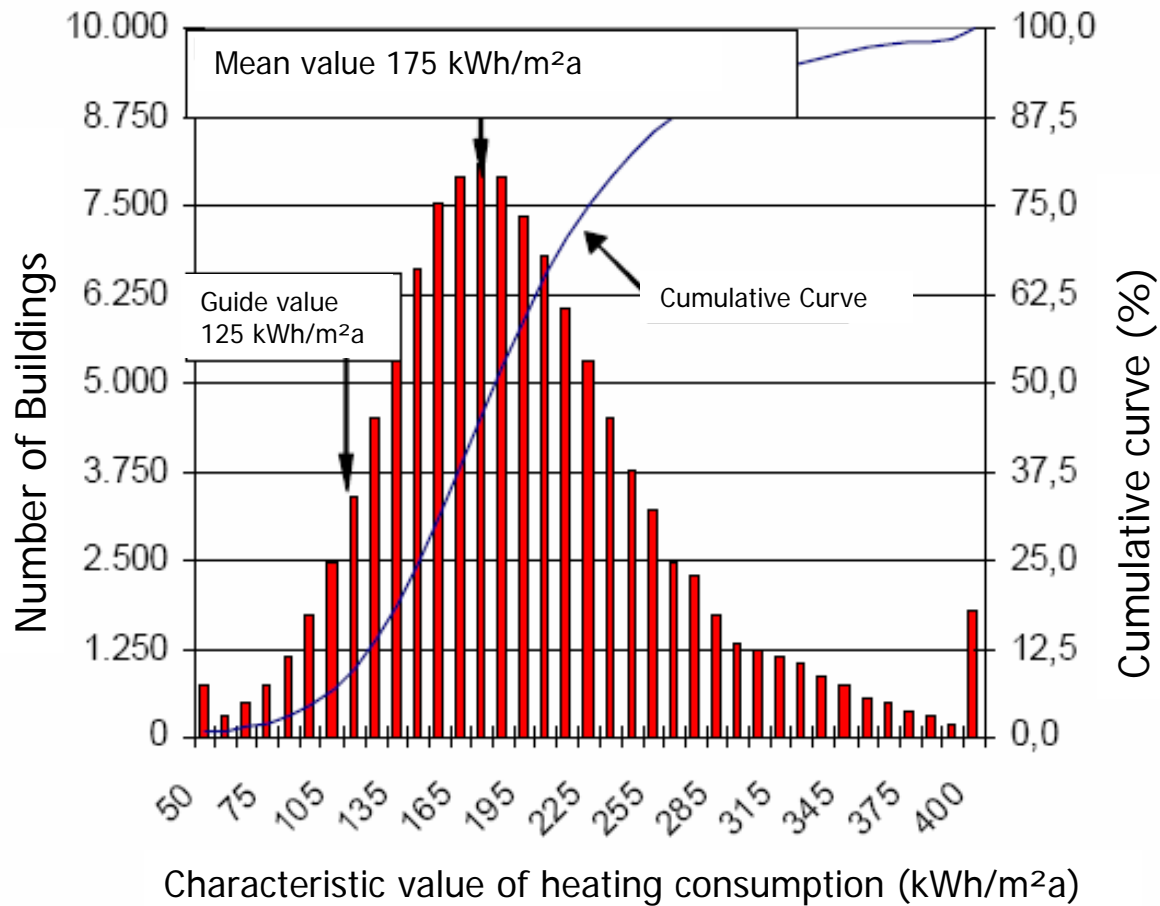
Existing buildings  New buildings

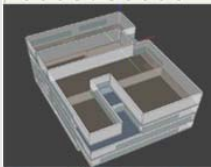


# Use of benchmarking

How to take advantage of intern/extern benchmarking

**Mean value** and **guide value** ( $\emptyset$  of best quarter)





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# Benchmarking of existing buildings (1998)

VDI 3807-2

Table 1. Mean and guide values in kWh/(m<sup>2</sup> a) for 15 groups of buildings (characteristic values of heating energy consumption have been outside temperature-compensated)

| BC <sup>1)</sup> | Description of building  | e <sub>VH</sub> |            | e <sub>VS</sub> |            | Source |
|------------------|--|-----------------|------------|-----------------|------------|--------|
|                  |  | Guide value     | Mean value | Guide value     | Mean value |        |
| 1200             | Court-houses   | 75              | 105        | 7               | 9          | 1      |
| 1310             | Administration buildings with standard technical equipment <sup>2)</sup> | 65              | 110        | 8               | 17         | 1      |
| 2000             | Buildings for scientific teaching and research                           | 95              | 155        | 12              | 15         | 1      |
| 3200             | Hospitals <sup>2)4)7)</sup>  | 15 800          | 22 800     | 3 000           | 5 100      | 3      |
| 4000             | Schools <sup>2)</sup>  | 55              | 90         | 4               | 7          | 1      |
| 4400             | Day nurseries  | 80              | 95         | 7               | 16         | 1      |
| 4410             | Pre-school nurseries   | 65              | 120        | 5               | 6          | 1      |
| 5000             | Sports buildings   | 65              | 140        | 8               | 17         | 1      |
| 5200             | Indoor swimming bathes <sup>2)3)7)</sup>                                 | 1 800           | 3 895      | 414             | 808        | 2      |
| 5500             | Open air swimming bathes (heated) <sup>2)3)7)</sup>                      | 195             | 280        | 37              | 85         | 2      |
|                  | One-/two-family houses <sup>5)6)</sup>                                   | 135             | 195        | 22              | 27         | 4.5    |
| 6120             | Multiple dwellings <sup>5)6)</sup>                                       | 125             | 175        |                 |            | 4.5    |
| 7200             | Stores and shops   | 45              | 65         | 58              | 81         | 1      |
| 7700             | Buildings for public stand-by services                                   | 70              | 155        | 5               | 10         | 1      |
| 9150             | Community buildings  | 50              | 80         | 4               | 5          | 1      |

e<sub>VH</sub> Characteristic value for heating energy consumption in kWh/(m<sup>2</sup> a) according to VDI 3807 Part 1

e<sub>VS</sub> Characteristic value for electricity consumption in kWh/(m<sup>2</sup> a) according to VDI 3807 Part 1

<sup>1)</sup> Building classification according to catalogue of the ARGE-Bau, see Annex A and bibliography

<sup>2)</sup> Further subdivision in subclause 6.3

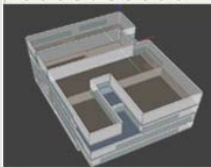
<sup>3)</sup> Characteristic values refer to the pool surface area in kWh/(m<sup>2</sup> a)

<sup>4)</sup> Characteristic values refer to the scheduled number of beds in kWh/a

<sup>5)</sup> Characteristic values refer to the living area in kWh/(m<sup>2</sup> a)

<sup>6)</sup> It was not possible to differentiate between the characteristic values for electricity consumption.

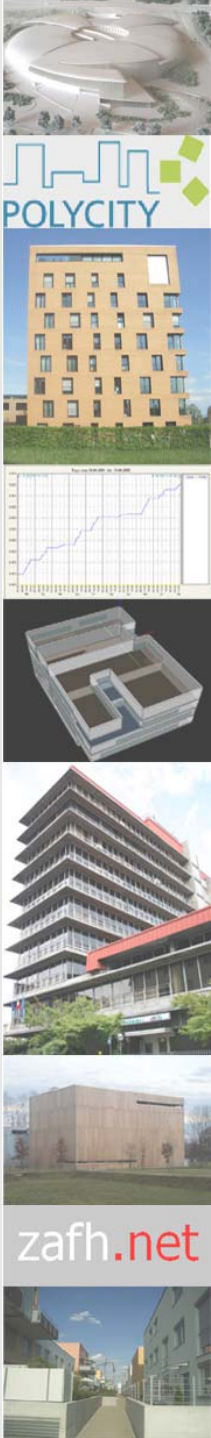
<sup>7)</sup> Due to the high outside temperature independent proportion of the characteristic value of heating energy consumption no compensation was made.



# Use of benchmarks

...to give you an idea where to save how much !

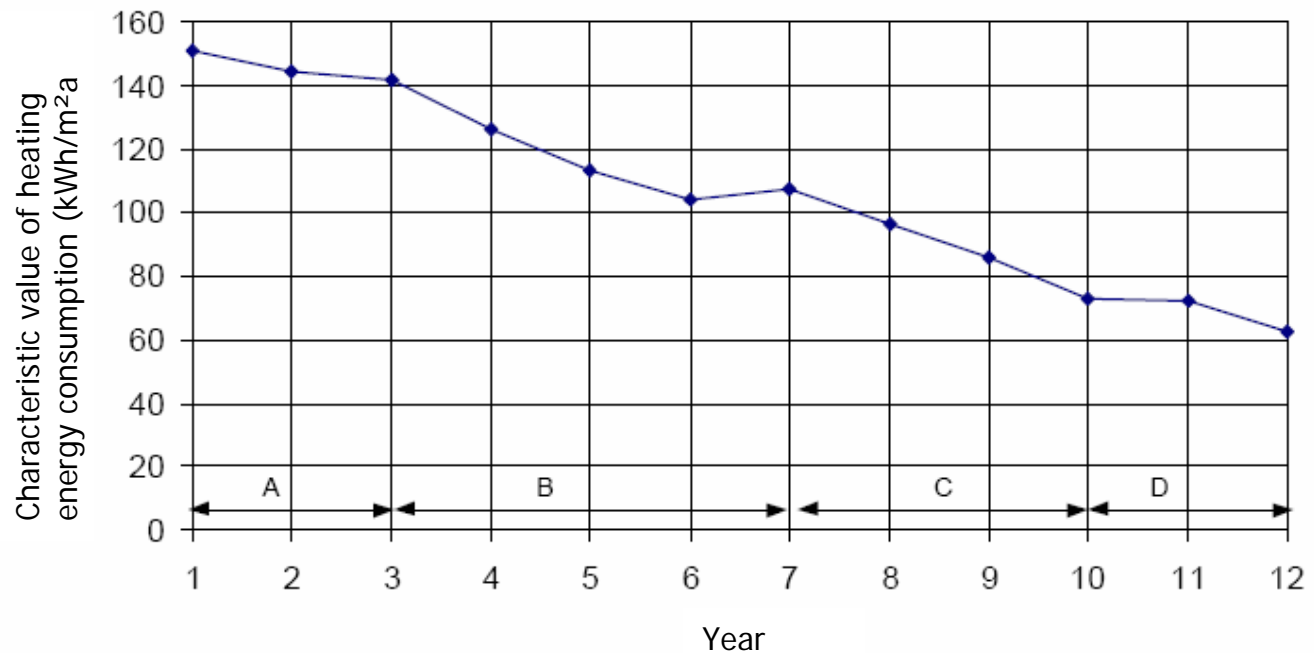
| Object           | Electric consumption | Related area      | Char. value electric consumption | Guide value               | Saving option             | Saving option | Part of total saving |
|------------------|----------------------|-------------------|----------------------------------|---------------------------|---------------------------|---------------|----------------------|
|                  | in kWh/a             | in m <sup>2</sup> | in kWh/(m <sup>2</sup> a)        | in kWh/(m <sup>2</sup> a) | in kWh/(m <sup>2</sup> a) | in kWh/a      | in %                 |
| Schulzentrum A   | 435 000              | 24 167            | 18                               | 9                         | 9                         | 217 500       | 24,5                 |
| Gymnasium B      | 265 297              | 11 054            | 24                               | 9                         | 15                        | 165 811       | 18,6                 |
| Mehrzweckhalle F | 123 421              | 4 937             | 25                               | 5                         | 20                        | 98 737        | 11,1                 |
| Schule C         | 126 862              | 5 286             | 24                               | 7                         | 17                        | 89 861        | 10,1                 |
| Mehrzweckhalle D | 67 800               | 2 119             | 32                               | 5                         | 27                        | 57 206        | 6,4                  |
| Mehrzweckhalle O | 60 425               | 2 877             | 21                               | 5                         | 16                        | 46 038        | 5,2                  |
| Mehrzweckhalle H | 45 600               | 1 689             | 27                               | 5                         | 22                        | 37 156        | 4,2                  |
| Mehrzweckhalle K | 43 967               | 1 912             | 23                               | 5                         | 18                        | 34 409        | 3,9                  |
| Kindergarten E   | 56 732               | 3 782             | 15                               | 6                         | 9                         | 34 039        | 3,8                  |
| Feuerwehr M      | 44 100               | 2 321             | 19                               | 10                        | 9                         | 20 889        | 2,3                  |
| Freibad          | 560 230              | 6 366             | 88                               | 85                        | 3                         | 19 099        | 2,1                  |
| Musikschule      | 23 490               | 691               | 34                               | 7                         | 27                        | 18 654        | 2,1                  |
| Grundschule G    | 34 200               | 2 012             | 17                               | 9                         | 8                         | 16 094        | 1,8                  |
| Kindergarten J   | 21 567               | 1 348             | 16                               | 6                         | 10                        | 13 479        | 1,5                  |
| Ortsverwaltung P | 45 000               | 2 143             | 21                               | 17                        | 4                         | 8 571         | 1,0                  |
| Ortsverwaltung N | 31 056               | 1 350             | 23                               | 17                        | 6                         | 8 102         | 0,9                  |
| Grundschule L    | 13 900               | 1 158             | 12                               | 9                         | 3                         | 3 475         | 0,4                  |



# Use of benchmarks

Existing buildings:

Reducing energy consumption in several steps

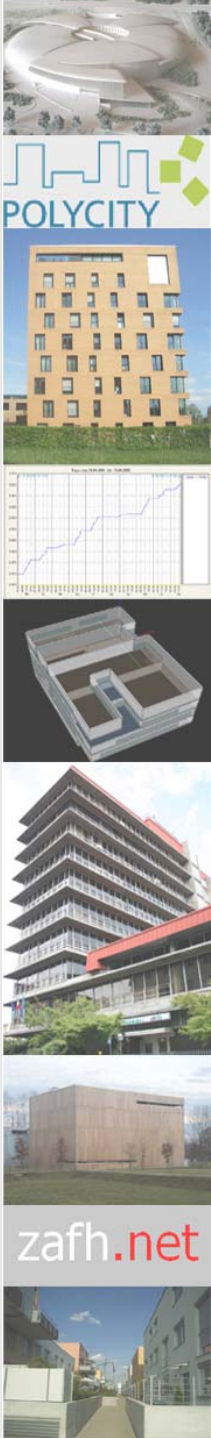


Step A: Original state

Step B: Influence of consumption control

Step C: Outside insulation of building envelope

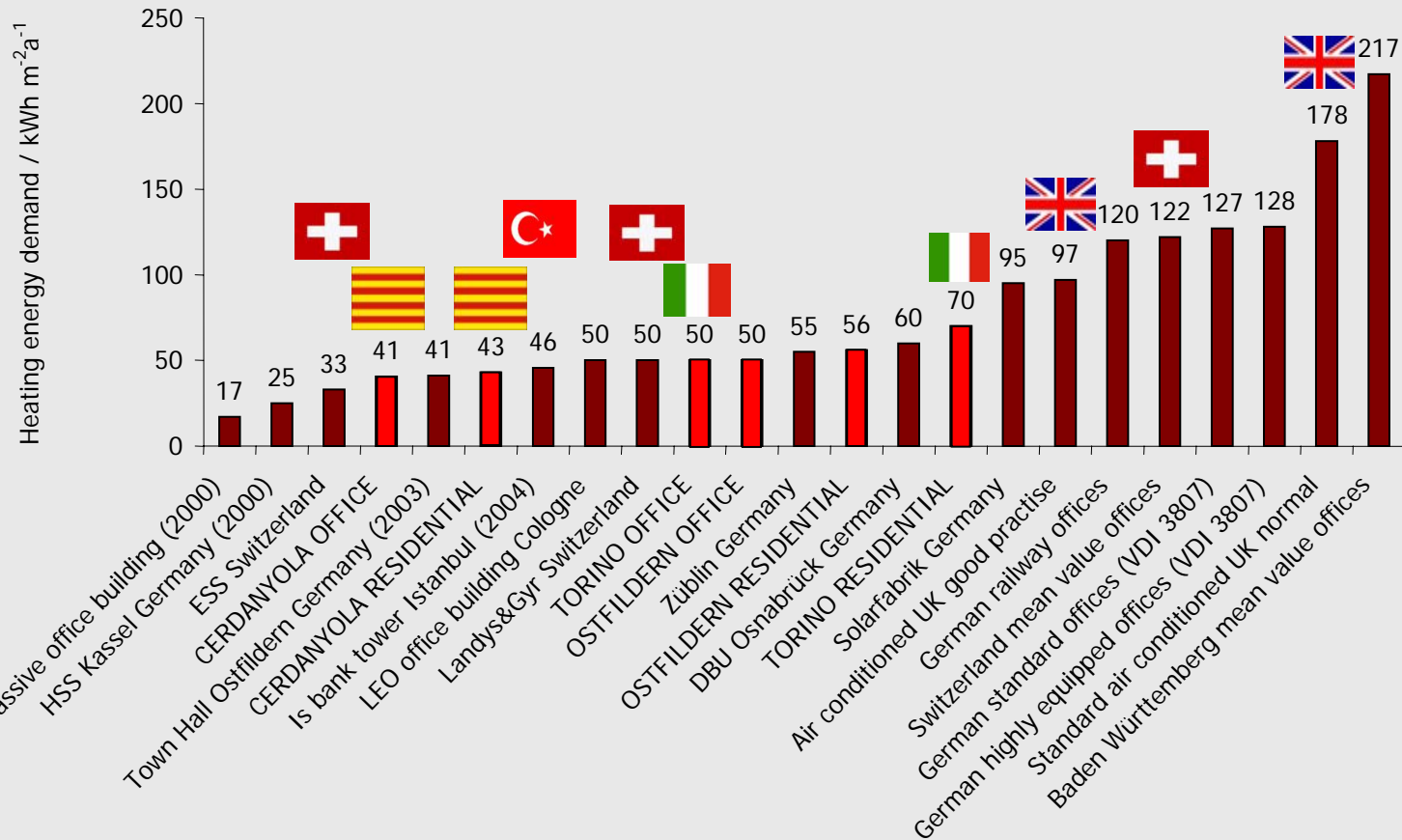
Step D: Controlling and evaluation

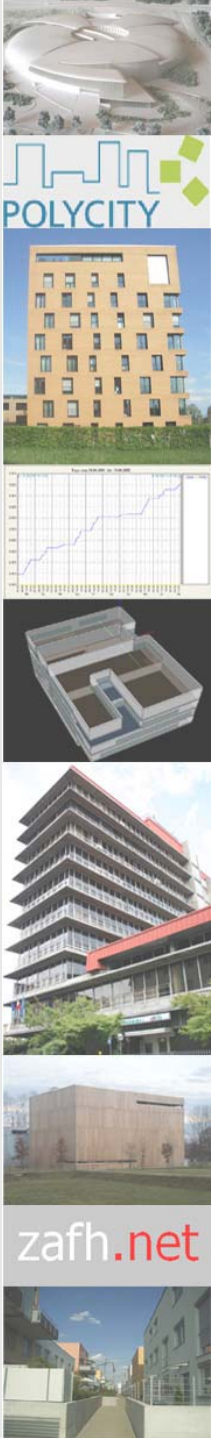


# Benchmarking for **new** buildings

## Best practise examples

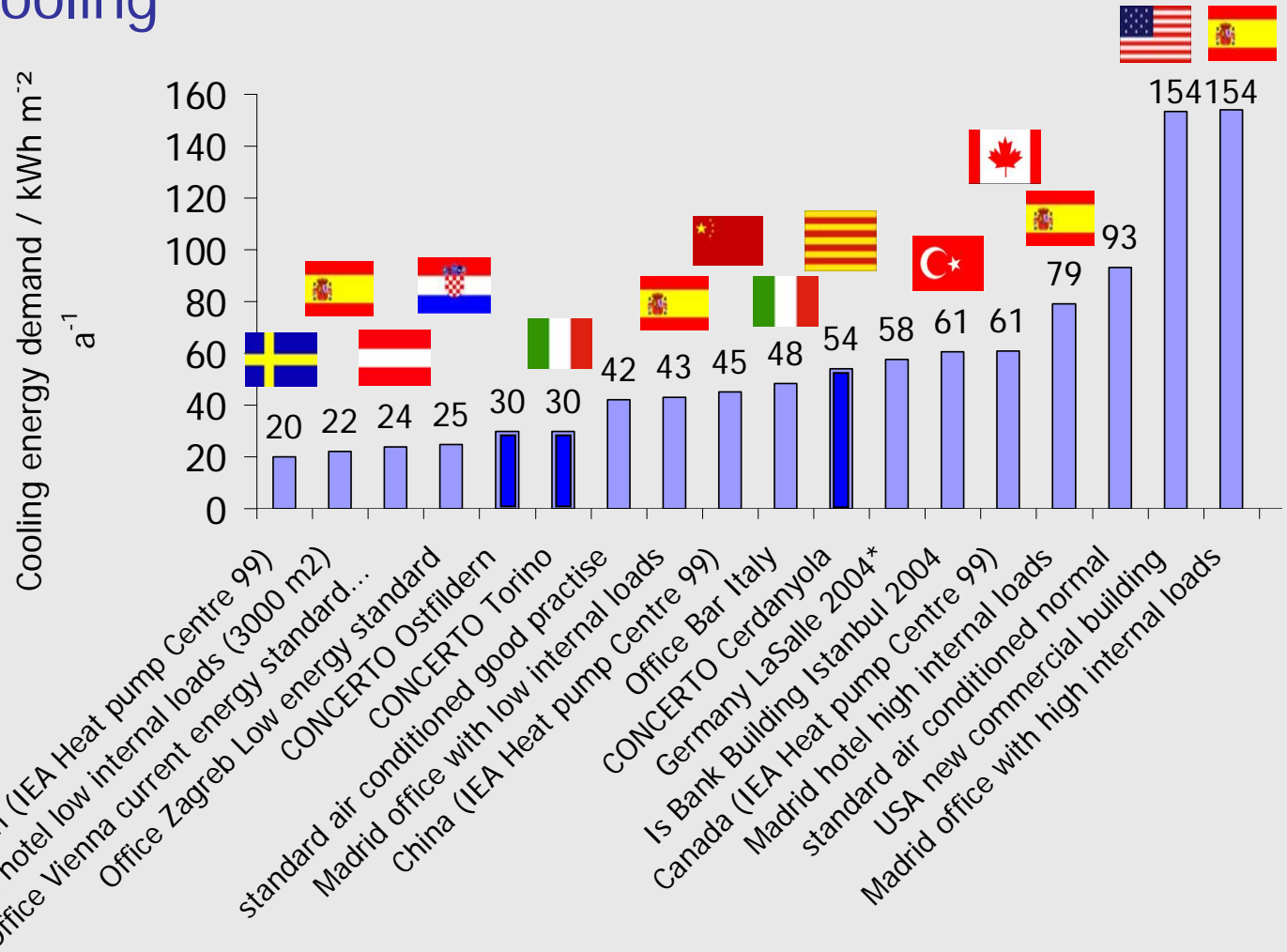
### Heating

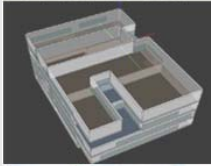




# Examples of benchmarking

## Cooling



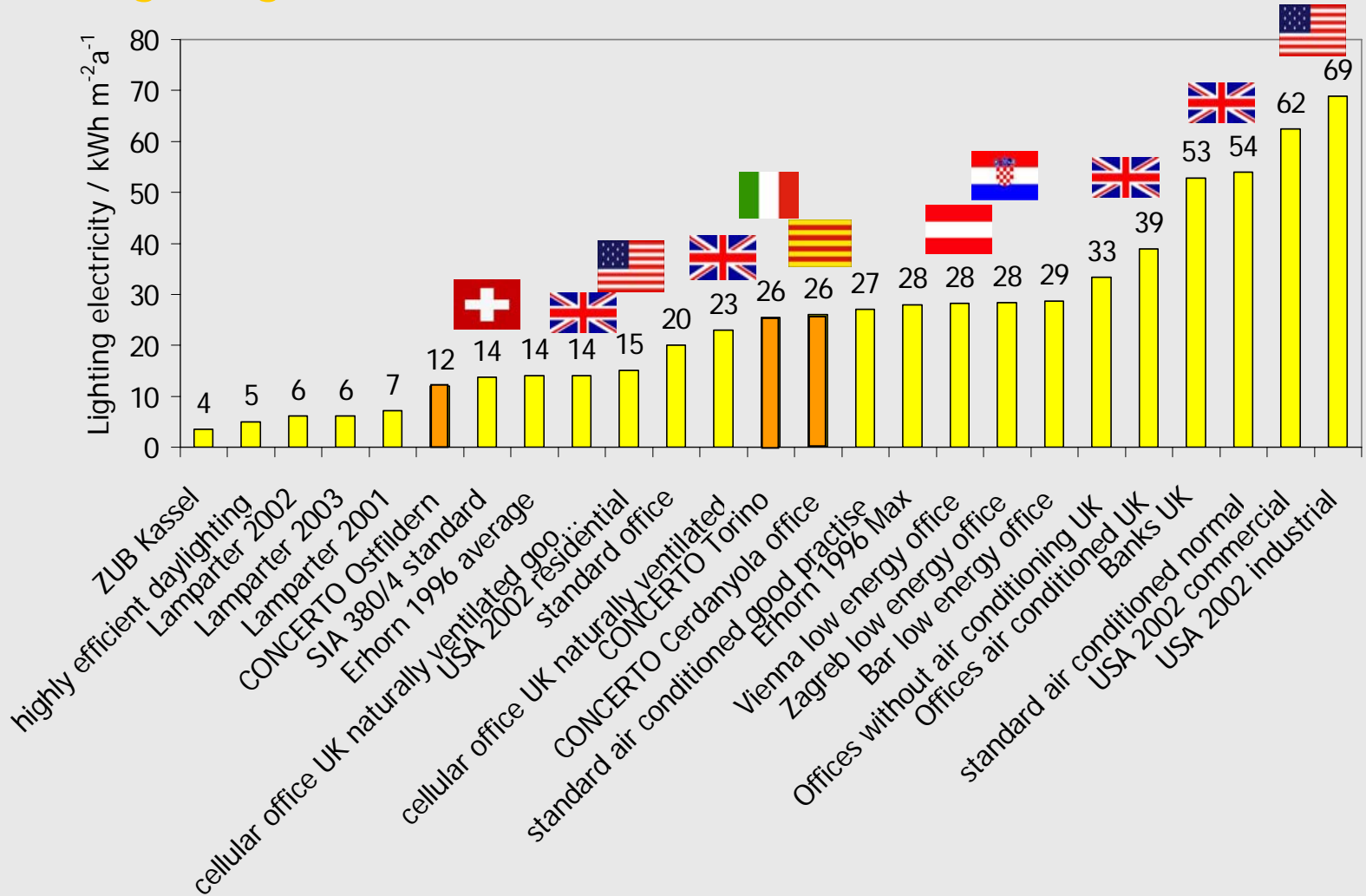


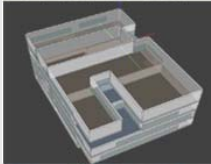
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# Examples of benchmarking

## Lighting





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# Conclusion and outlook

- Transparent calculation of indicators necessary (areas!)
- Benchmarking usually classifies the building compared to national averages (existing buildings)
- But: stronger emphasis on best practise examples for energy efficient buildings
- Aim: achieve best practise at reasonable costs