Technical description, sizing and calculation methods of solar systems in tourism

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- Dimensioning of the collector surface and the solar storage volume
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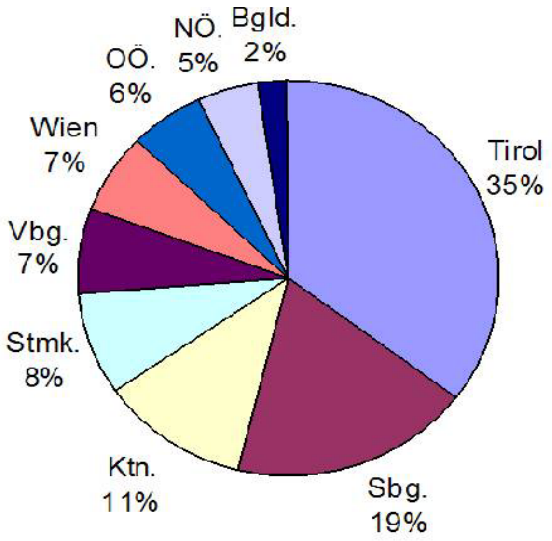
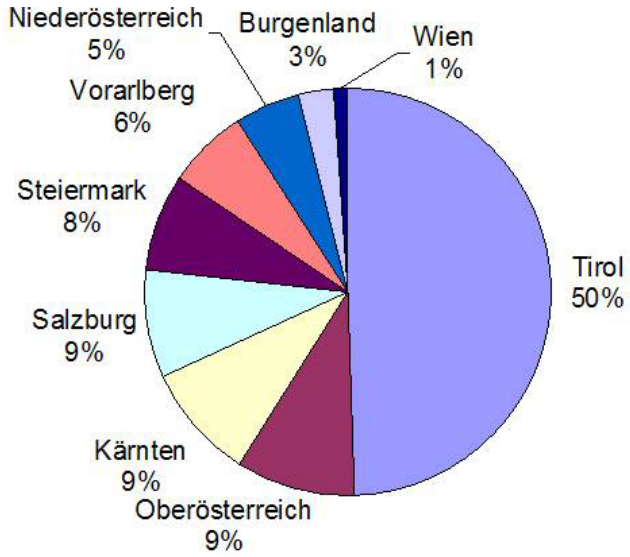
Introduction

- 115 million overnight stays in Austria in the year (73,000 enterprises)
  - 72.5 million in 15.000 commercial enterprises
    - 2.000 with a solar plant -> 50.000 m²
    - Solar market penetration of approximately 13% (basis: 15,000 enterprises)
    - Solar covering at the heat requirement scarcely 2.5% (Consumption altogether: 250 millions litre fuel oil)

overnight stays :



collector area :



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Application in tourism enterprises

- Heating up of free and/or indoor swimming pools
- Heating up of hot water
- Support of heating

Solar systems for toursim

Hotel, Carinthia

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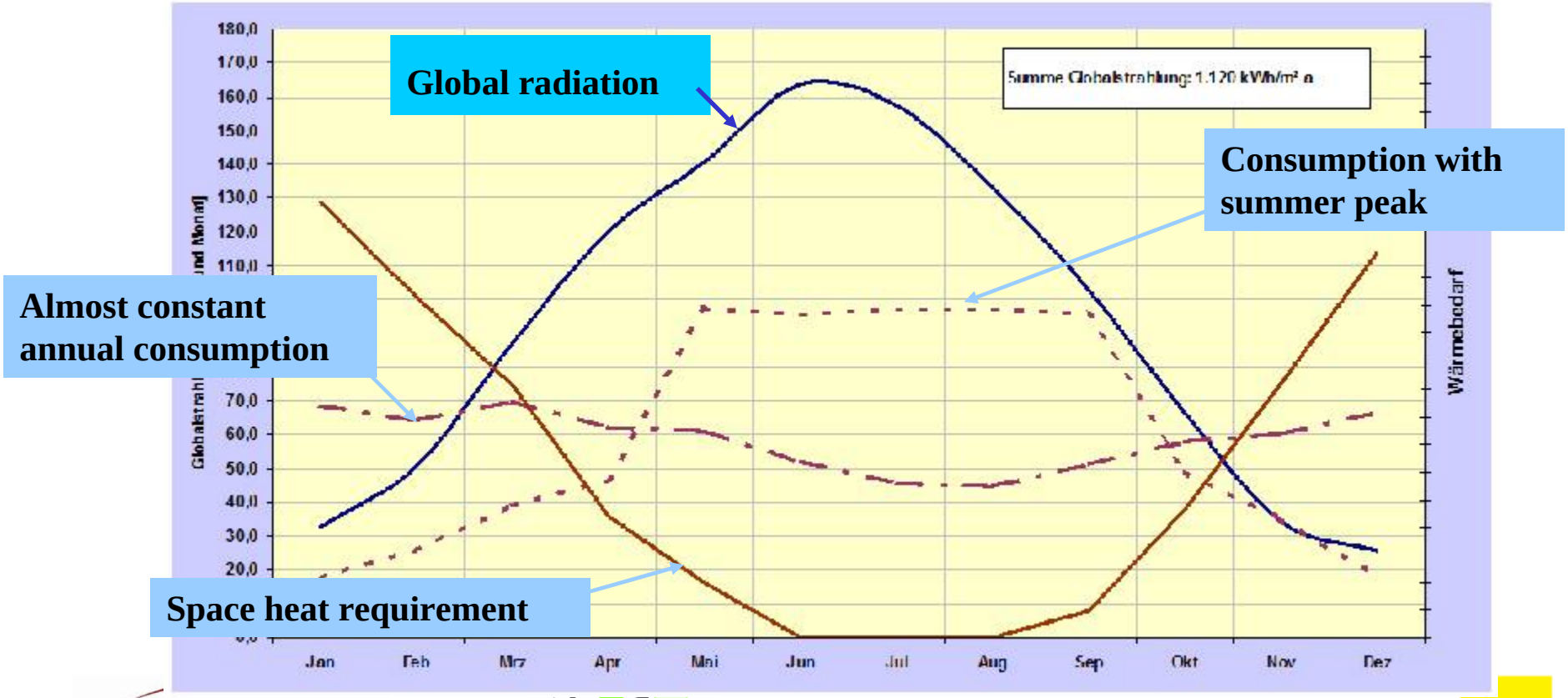
Solar radiation vs. heat demand over the year

Optimal:

Good accordance of the heat requirement with times of high solar radiation



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Determination of the demand – Basis of dimensioning

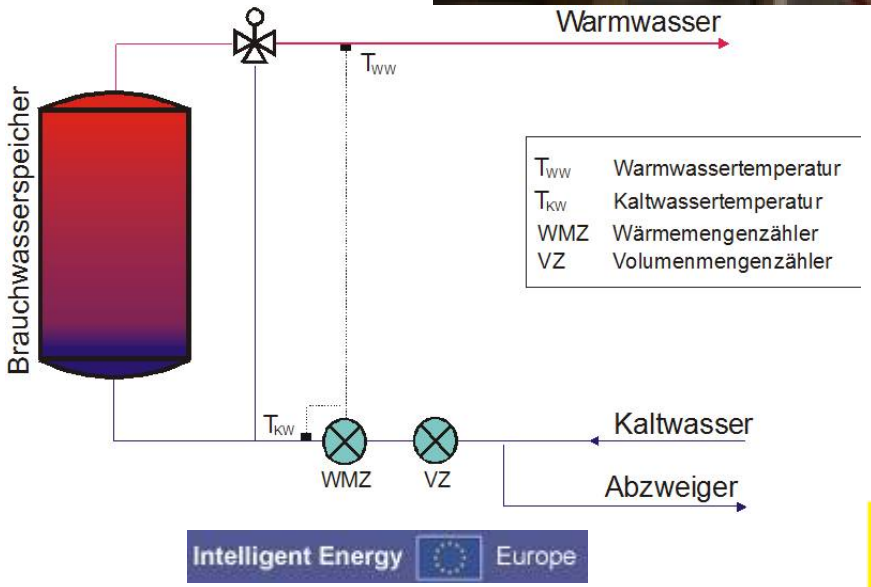
Determination of the demand:

- Hot water demand
  - At least during some weeks
  - Determination based on experience
- Heat demand
  - Costs
  - Determination
- Basin surface losses of the swimming pool
  - Determination
- 3 different ways to dimension a system:
  - Cost/use optimum
  - Gain of the collector as high as possible during times without stagnation
    - > Inclination <45° usage in summer, 30° < collector inclantion < 35° higher winter gain
  - Basis is the average hot demand from May to September

Determination of the hot water demand

- Measuring devices:
  - volumetric meter (constant T)
  - heat meter (also with varying T)

- At least during some weeks
- Daily values sufficiently
- Consider the position!



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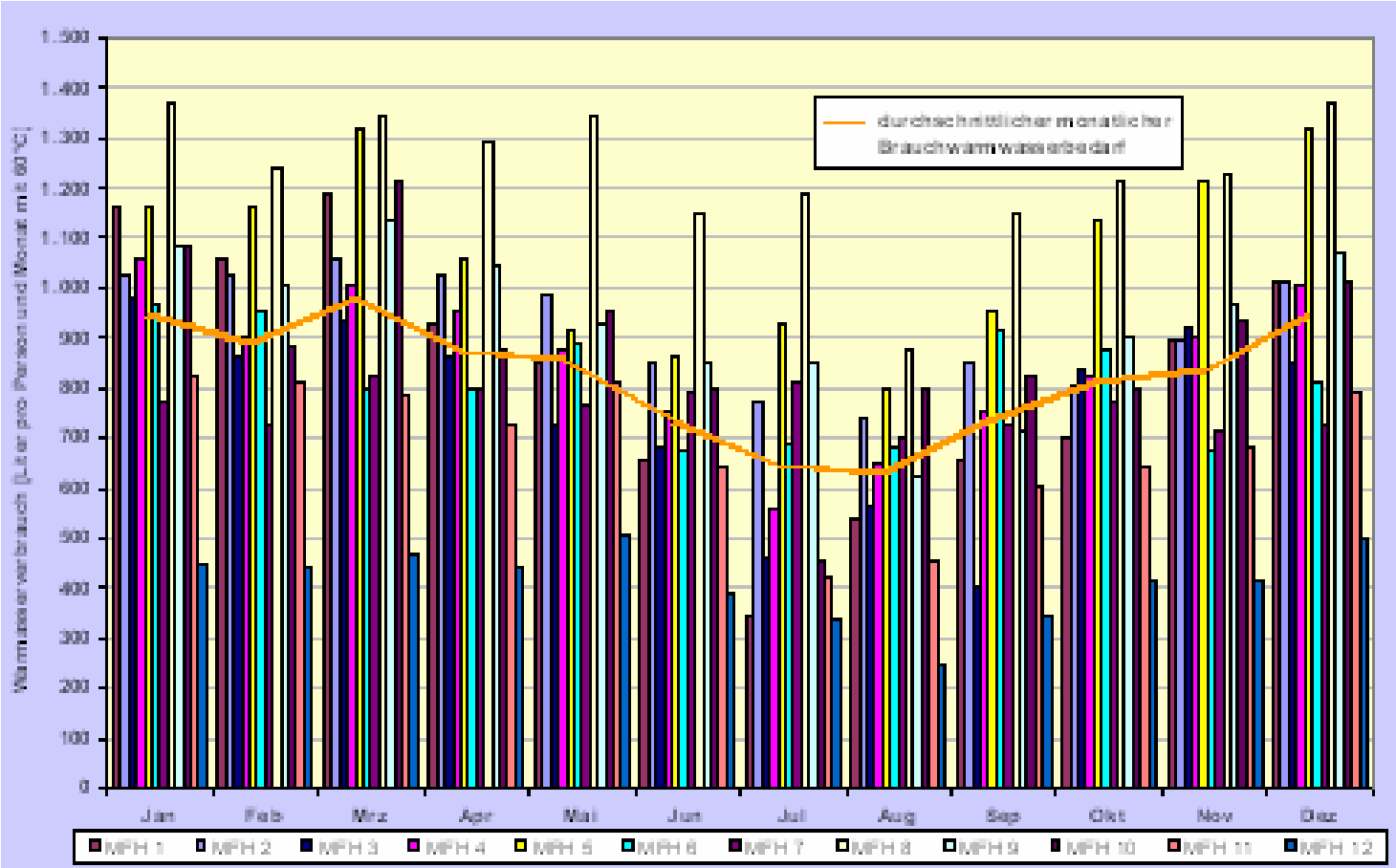

- Average hot water consumption (monthly/year) for 12 different dwellings – average water demand per person/month 60°C

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Determination of the hot water demand

- Determination based on experience
- Category of the enterprise
  - Hotel (3 to 4 stars): approx. 40-60 l per day and guest (60°C)
  - Bed and breakfast: approx. 30 l per day and guest (60°C)
  - Appartments: approx. 40 l per day and guest (60°C)
  - Youth hostels: approx. 20 to 25 l per day and guest (60°C)
  - Camping sites: approx. 20 l per day and guest (60°C)
- What is additionally supplied?
  - Kitchen
  - Sauna and fitness room
  - Etc.
- Breakfast approx. 2-3 l per guest (60°C)
- Noon/dinner approx. 4-8 l per guest (60°C)

$$\mathbf{demand_{Periode} = V_{Gast} \times occupancy\ rate_{Periode} \times number\ of\ beds}$$

Determination of the hot water demand

- Category of the enterprise
  - Bed and breakfast, 100% breakfast
  - Maximum number of beds: 60
  - Overnight stays from May to August: 5.500
  - Number of days from May to August: 123
- Personal hot water consumption per day
  - Hot water consumption: approx. 30 l/Tag and person (60°C)
  - Breakfast (100%): approx. 2l per guest (60°C)
  - Entirely: VGast = approx. 32l (60°C)
- Middle summer occupancy rate of utilization (May until August)
  - Occupancy rate = number of beds / (number of days x number of beds available) = 5.500/(123 x 60) = 0,745
- Average daily consumption of hot water (May until August)
  - Average daily consumption of hot water = VGast x occupancy rate x number of beds = 32 x 0.745 x 60 = 1,430 l/60°C and day

Dimensioning of the collector area: 1.option

Rough estimation of the gross collector surface A_{Koll} (SD approx. 30 to 40%)

$$A_{coll} = \frac{Q_{HW}^{0,75}}{6,05}$$

$$Q_{HW} = average\ hot\ water\ demand\ from\ May\ to\ August\ [liter\ with\ 60°C / day]$$

Example from last page:
Bed and breakfast
Maximum number of beds: 60
Overnight stays from May to August according to information: 5.500
Number of days from May to Septembers: 123
Daily consumption: 1,430 litres with 60°C
Determination of the collector area for hot water preparation for a solar covering degree of approx. 30 - 40 %.

$$A_{coll} = \frac{Q_{HW}^{0,75}}{6,05} = \frac{1.430^{0,75}}{6,05} = 38,5 m^2$$

→ **Collector area is appr. 40 m²**

Solar storage volume = A_{coll} [m²] * 60 [liter/m²] = 40 * 60 = 2.400 liter

→ **The necessary solar storage volume is appr. 2.400 liter**

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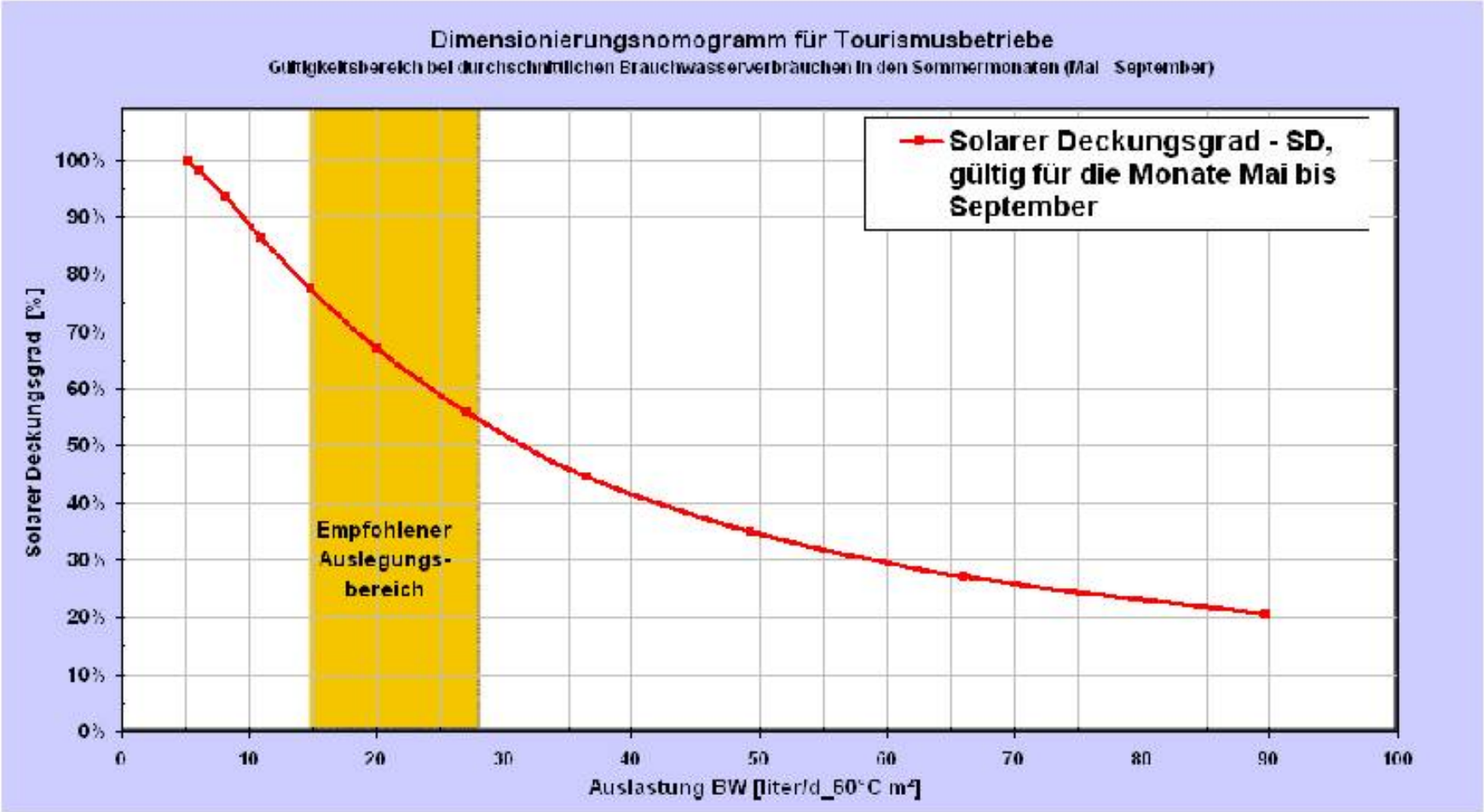
Dimensioning of the collector area: 2.option

Nomograph



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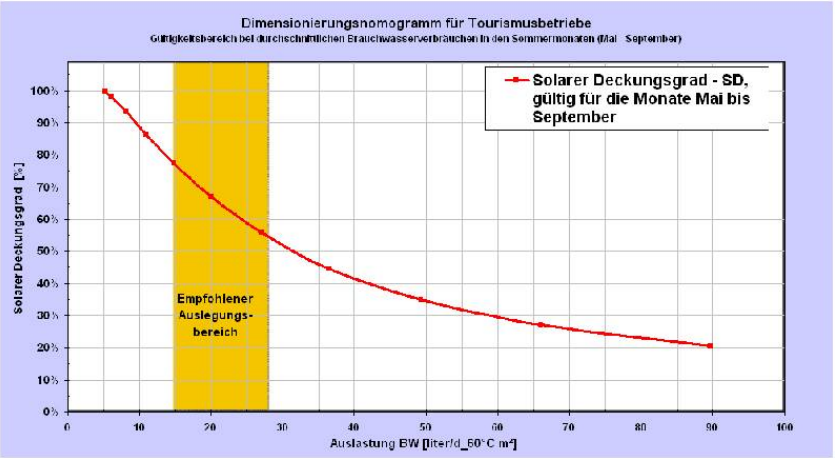
Dimensioning of the collector area: 2.option

Nomograph



Range of validity:

For summer months including May to September

Solar covering degree exclusively refers to the summer months

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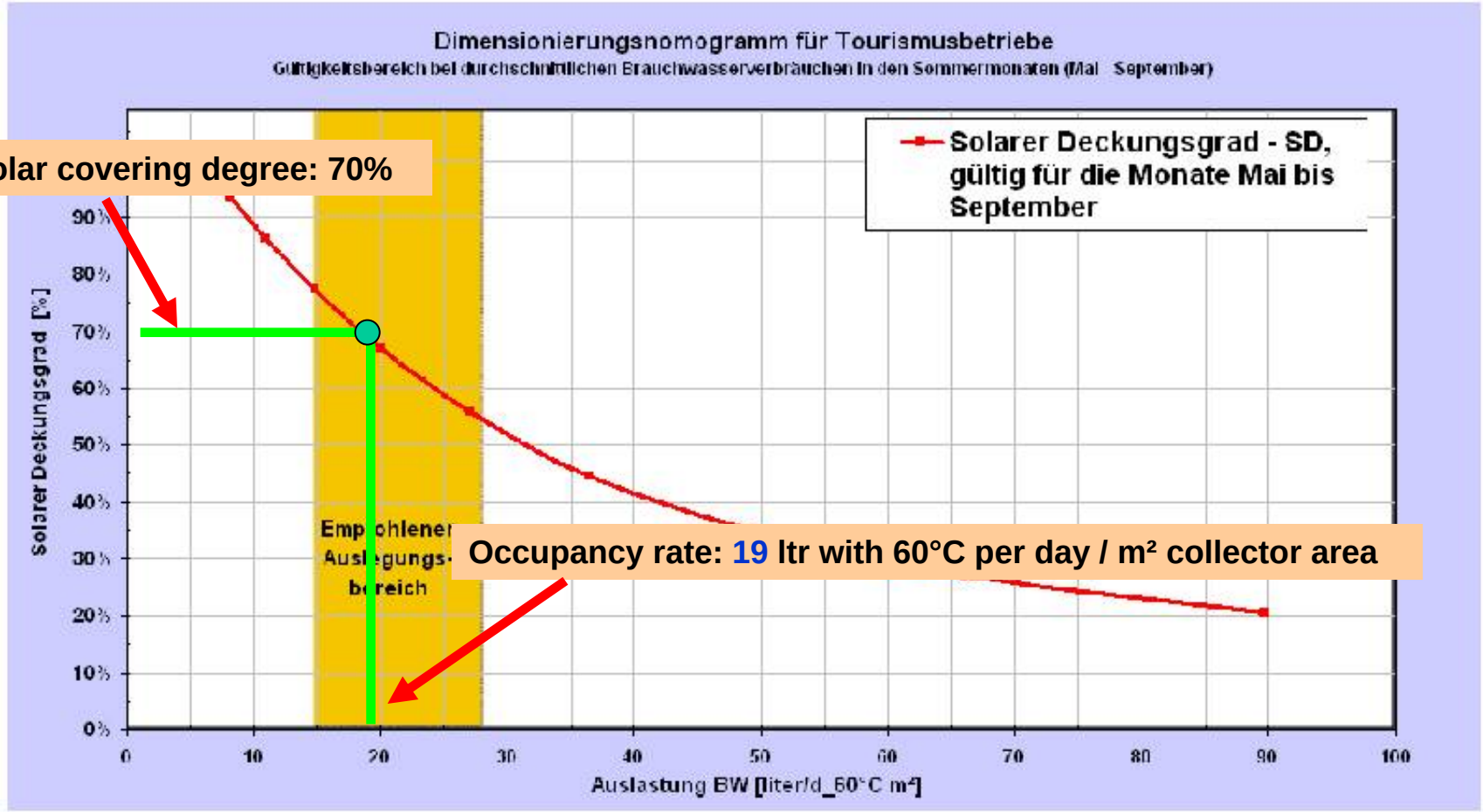
Example:

Bed and breakfast
Maximum number of beds: 60
Overnight stays from May to August according to information: 5.500
Number of days from May to August: 123
Determination of the collector surface for hot water preparation for a solar covering degree of approx. 70 % during the summer months.



Solar covering degree: 70%

Occupancy rate: 19 ltr with 60°C per day / m² collector area

Example:

Bed and breakfast
Maximum number of beds: 60
Overnight stays from May to August according to information: 5.500
Number of days from May to August: 123
Determination of the collector surface for hot water preparation for a solar covering degree of approx. 70 % during the summer months.

Determination of the collector area:

Occupancy rate: 19 ltr with 60°C per day / m² coll. area, hot water consumption 1.430 ltr with 60°C

$$\frac{\text{1430 liter with 60°C per day}}{\text{19 liter with 60°C per day / m² coll. area}} = \text{75 m² coll. area}$$

Determination of the solar storage volume:

Solar storage volume = A_{coll} [m²] * 60 [liter/m²] = 75 * 60 = 4.500 liter

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Rough dimensioning

Swimming pool

Rule of thumb:

Collector surface = basin surface x 0.5 to 1

Hot water

Rule of thumb for 40 - 70% solar covering:

Collector surface = 0.6 m ² to 1.4 m ² for each bed

(in dependence of occupancy rate and consumption)

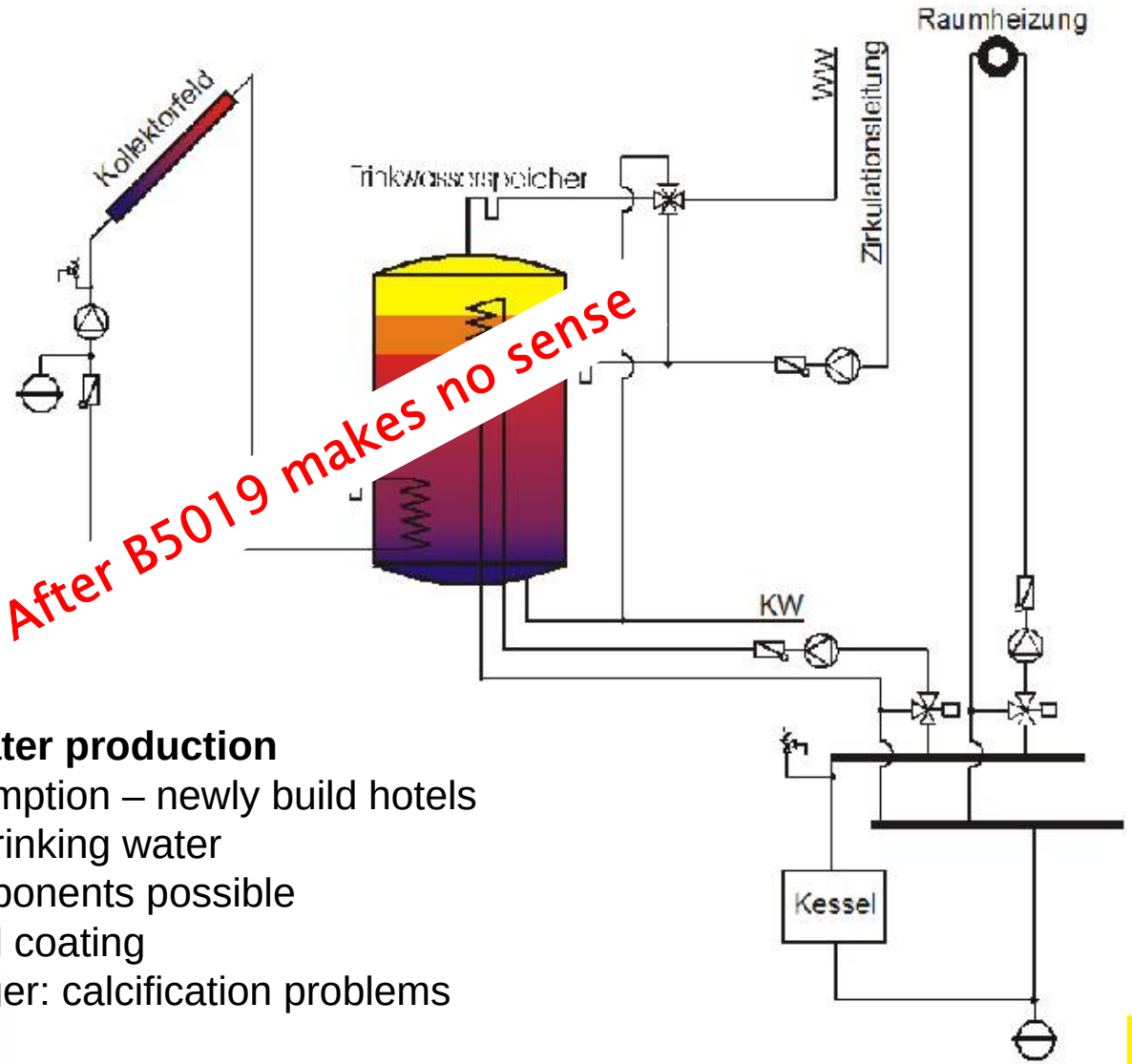
Space heating

- Particularly meaningfully, if collector surface can be further used in summer for the heat supply of a swimming pool
- Also if the solar system is just used for hot water preparation, select hydraulics which makes heater support possible

Rule of thumb for 15 - 20% solar covering:

Collector surface = 1.5 m ² to 2.5 m ² per KW of heating load

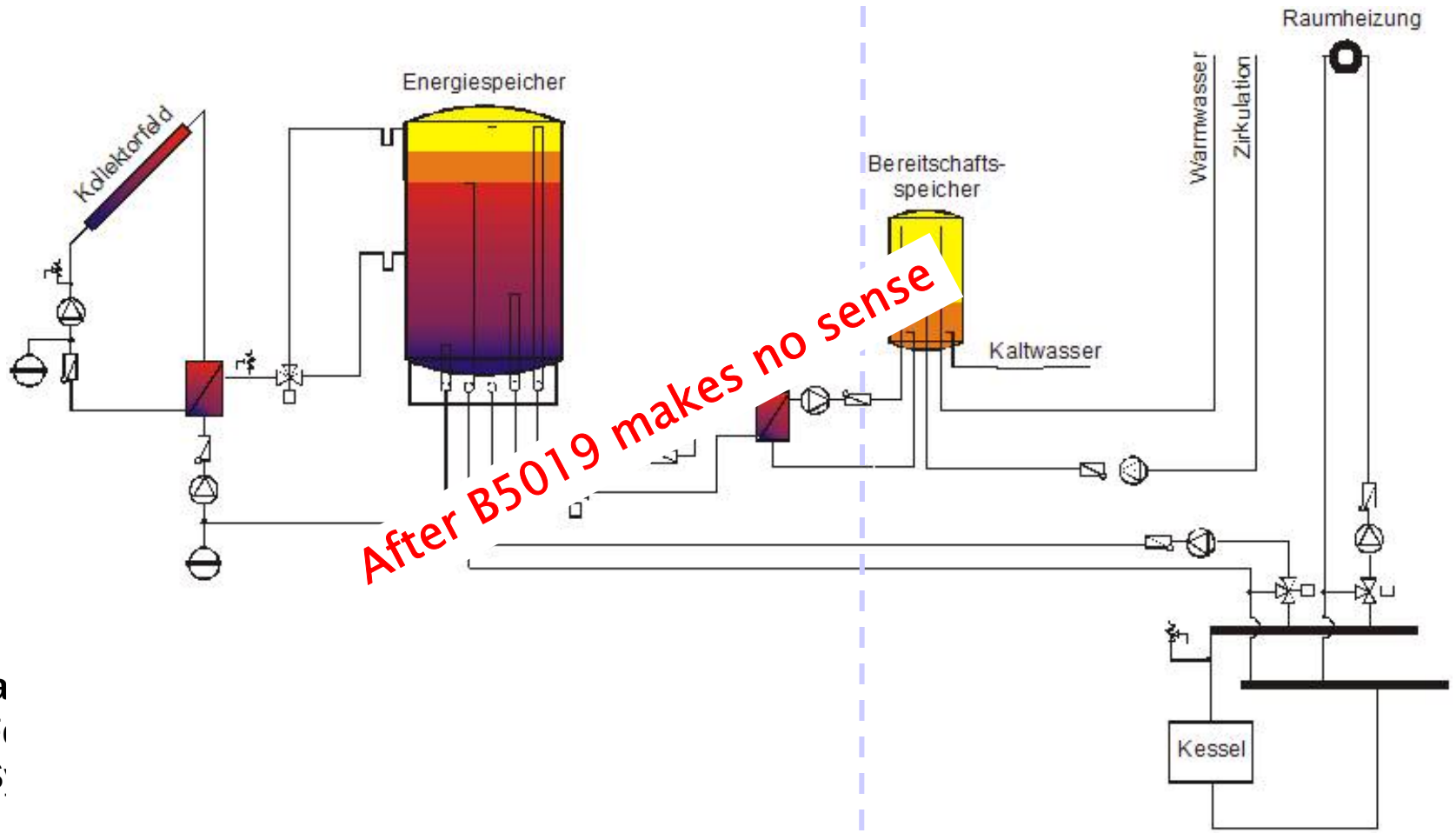
Hydraulic – Hot water storage



Solar supported hot water production

- System for low consumption – newly build hotels
- energy storage with drinking water
  - •Use of further components possible
  - •High cost – internal coating
  - •Plate heat exchanger: calcification problems

Hydraulic – 2 storage system



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- Energy storage with steal storage

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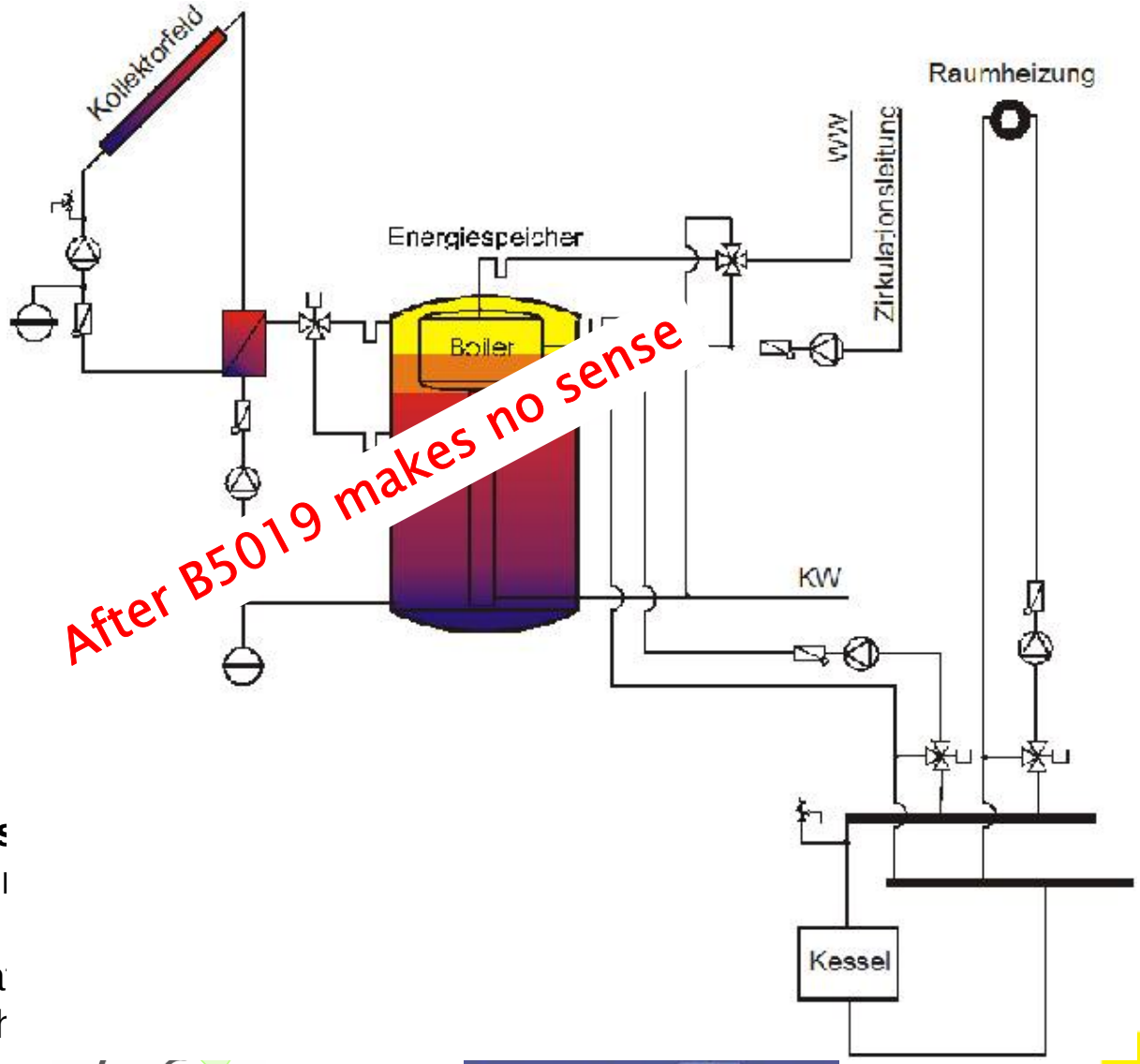
Hydraulic – Steal storage with integrated hot water storage



Solar supported sys

- System for low co
- Energy storage in
- Hot water prepara
- 10% more gain wh

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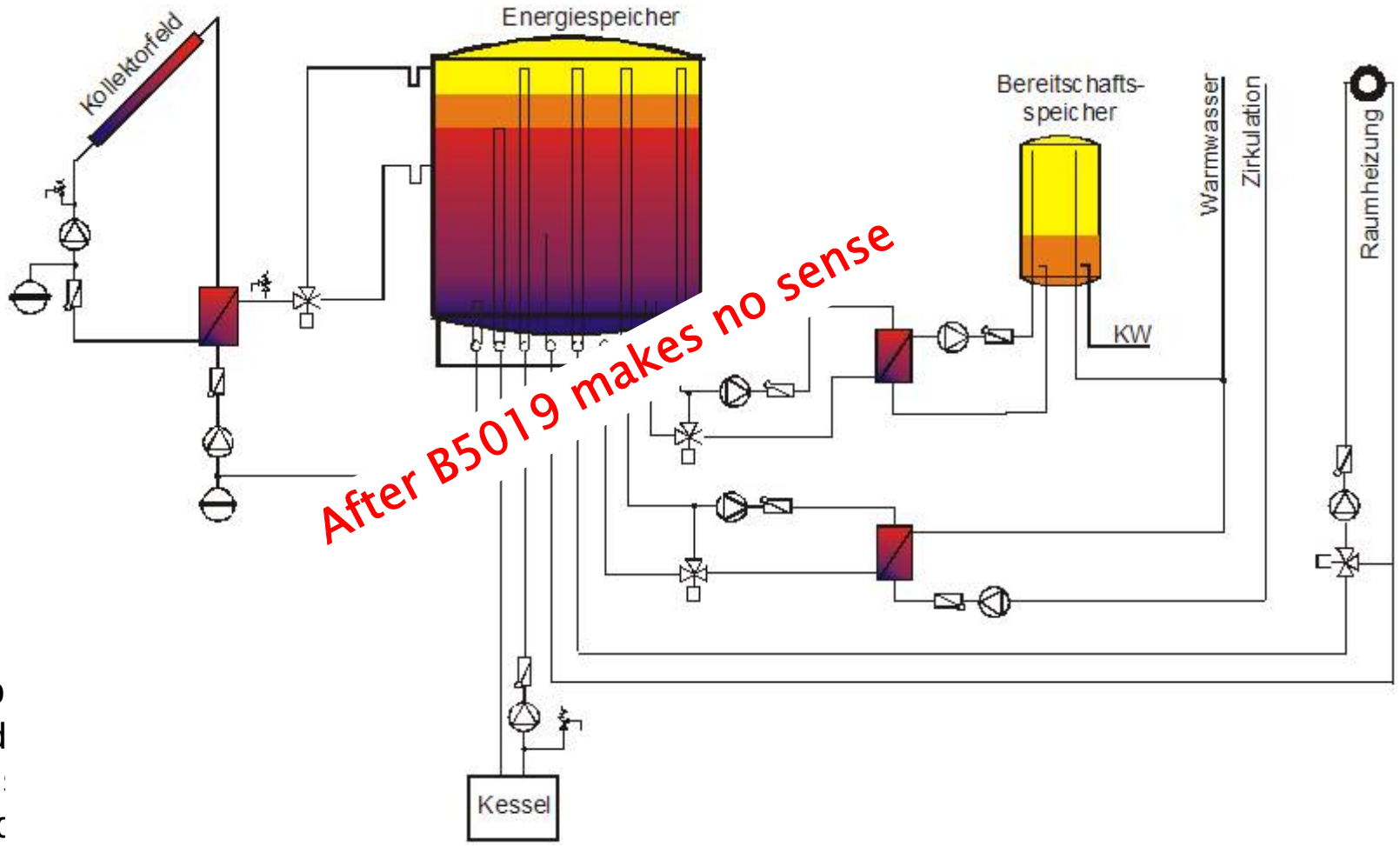
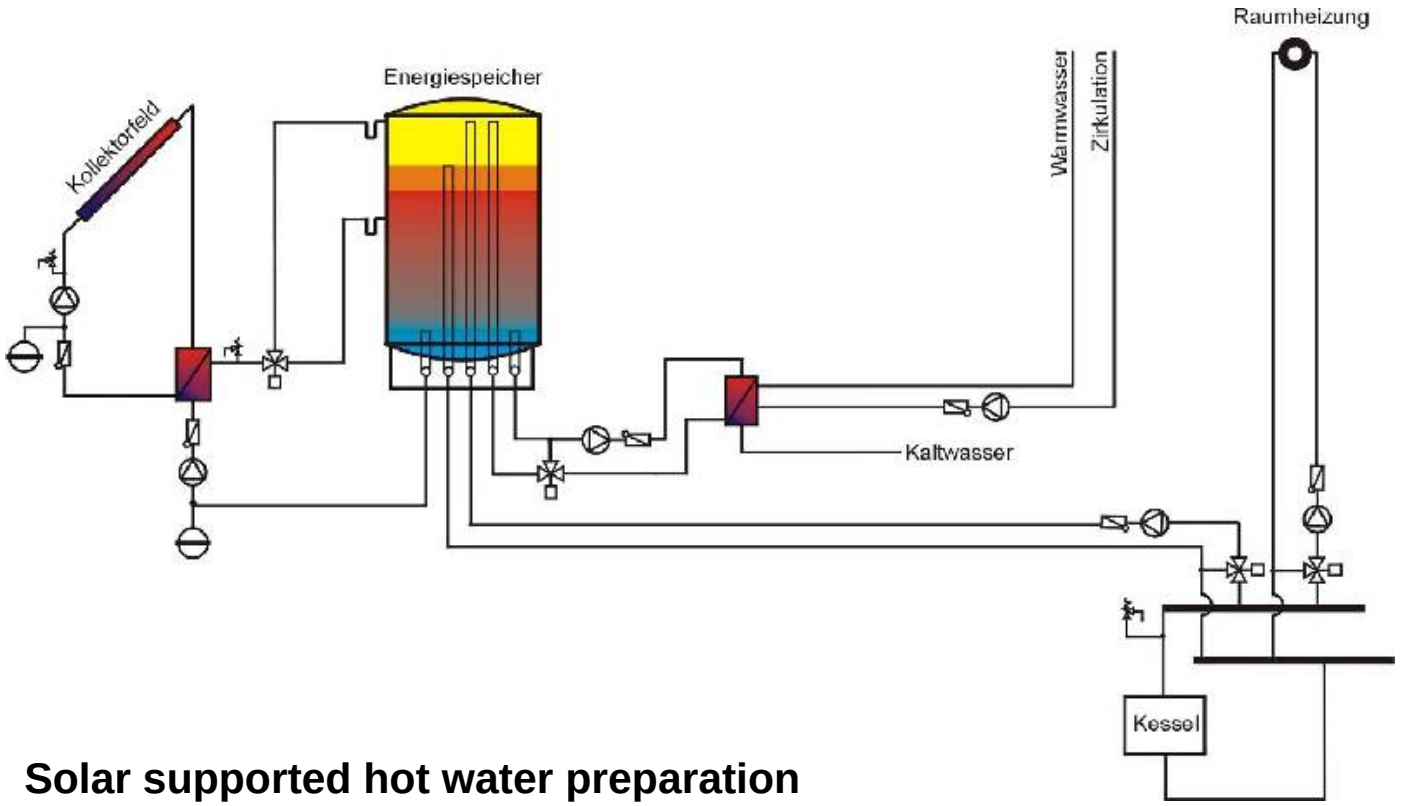
Hydraulic – Heat support



Hot water supply

- Two sto
- 4 pipe d
- Energy
  as a hyc

Hydraulic – Hot water preparation with a decentralised substation



Solar supported hot water preparation

- System for low consumption
- Energy storage in the steal storage
- Hot water preparation with a central extern heat exchanger

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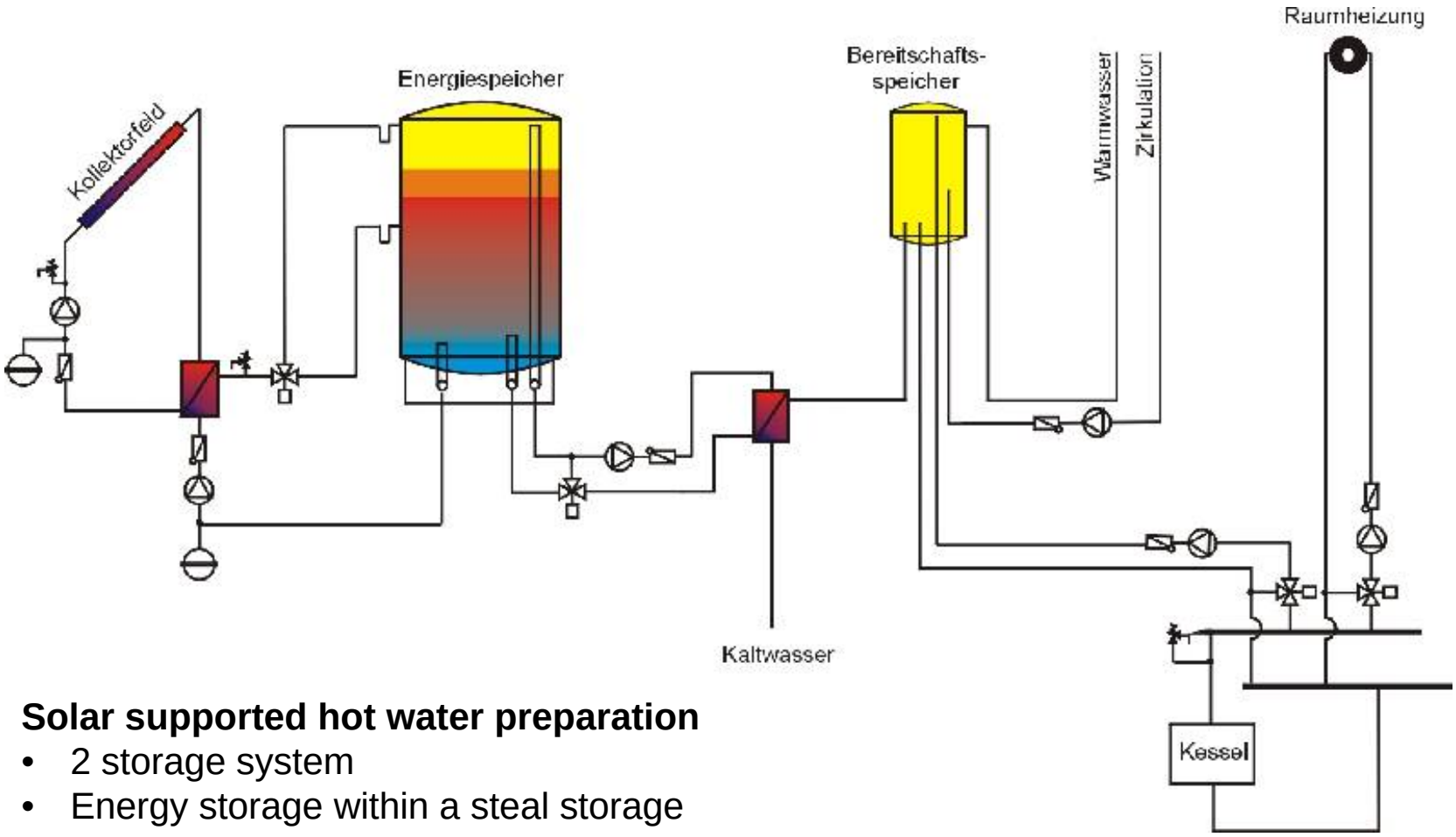
Hydraulic – Hot water preparation by using the solar system



Solar supported hot water preparation

- 2 storage system
- Energy storage within a steal storage
- Hot water preparation with an additional storage
- solare heating up with an external heat exchanger

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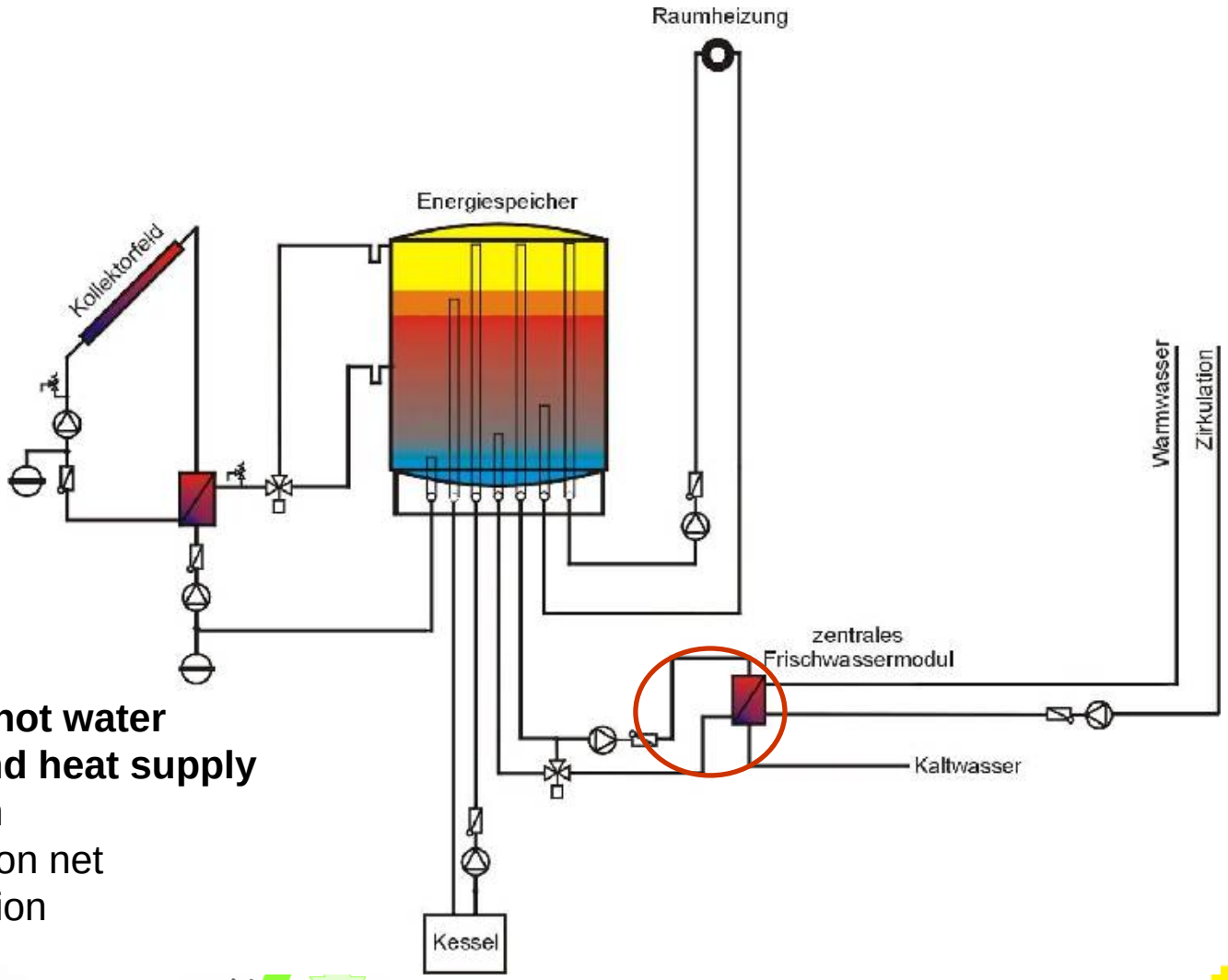
Hydraulic – Hot water preparation + heat supply



Solar supported hot water preparation and heat supply

- Storage system
- 4 pipe distribution net
- Central substation

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Other applications after the same principle

With a hot water consumption of more than **40** liters with 60° per person, elderly homes are optimal suitable for using a solar system

Other applications after the same principle

Elderly home Fürstenfeld

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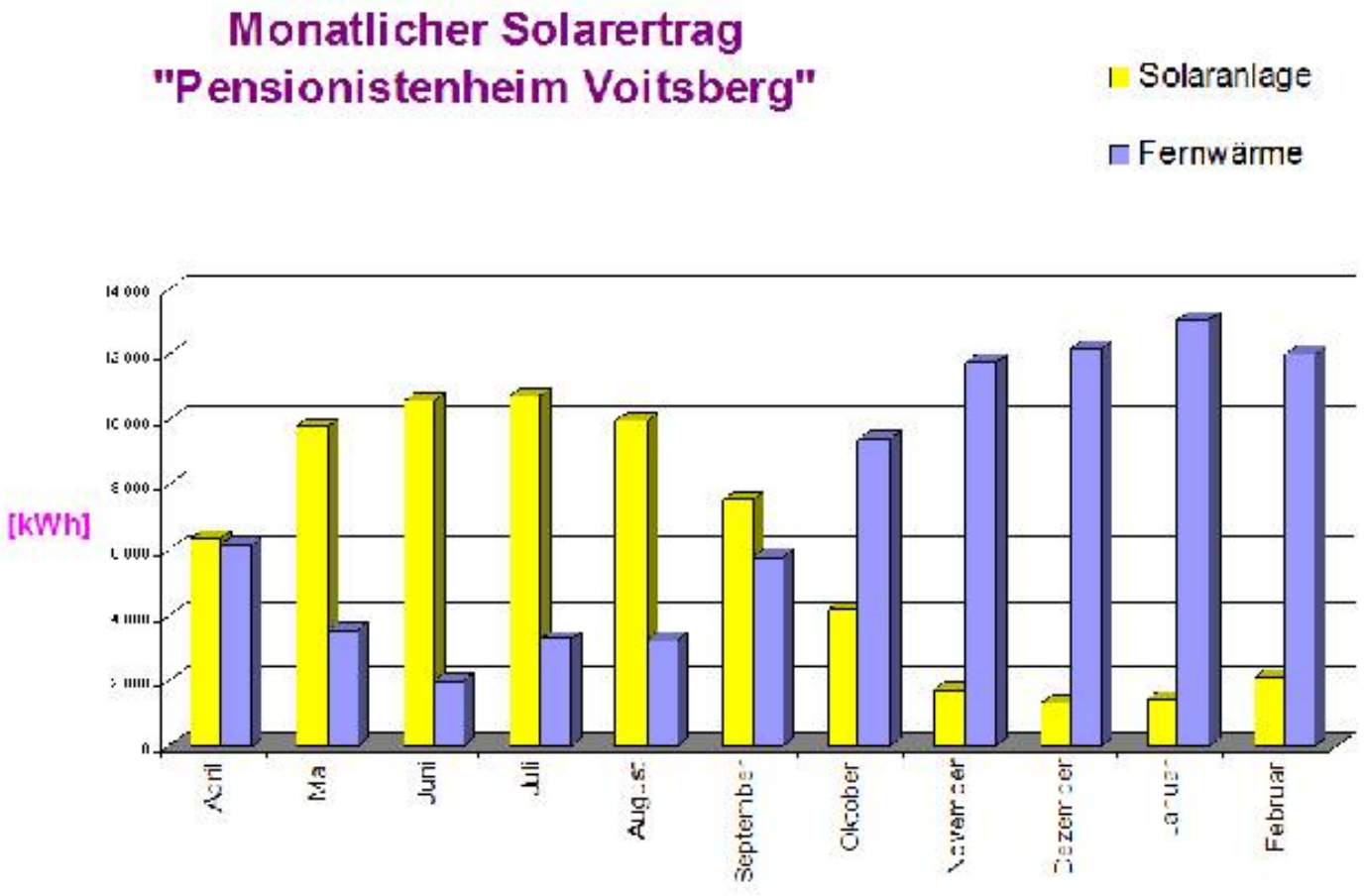
Solar hot water preparation at a elderly home in Voitsberg

- People living there ~150
- Daily hot water consumption ~6.000 liter with 60°C
- Solar system was installed in 2002
- Collector area 160 m²
- Storage volume: 5.000 liter
- Hot water storage volume: 1.250 liter
- Annual energy produced by the solar system: ~73.000 kWh

Solar hot water preparation at a elderly home in Voitsberg



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Solar hot water preparation at a sport stadium in Gleisdorf

Sport stadium, Gleisdorf

Bildquelle: Arch. Hohensinn

Combined system – Trainingscenter GAK

Bildquelle: Arch. Hohensinn

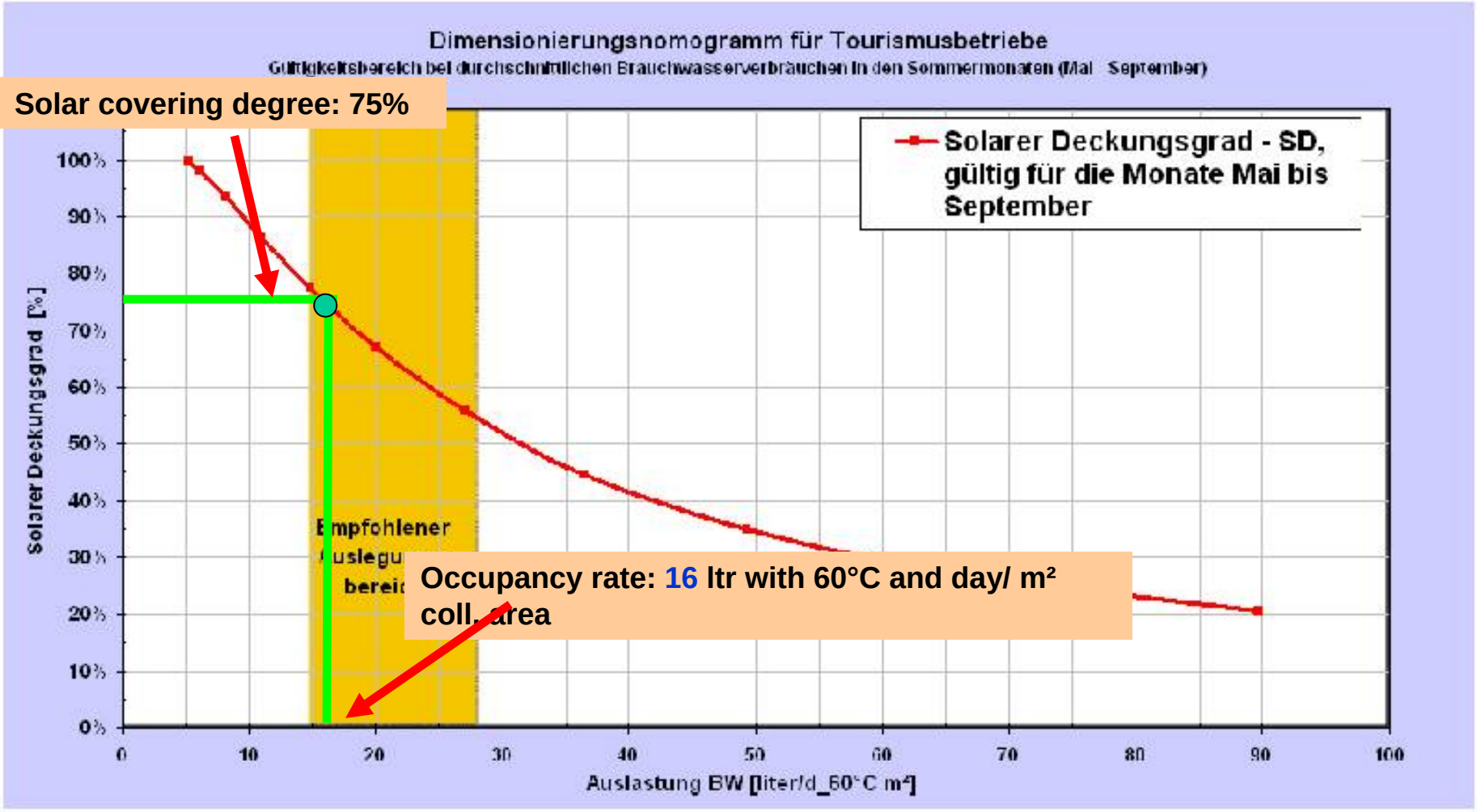
Example

- Category of the enterprise
  - Pension, 100% breakfast
  - Maximum number of beds: 40
  - Overnight stays from May to August: 3.800
  - Number of days from May to August: 123
- Given:
  - Over the summer, at least 75% of the hot water production should be covered by the solar system
- Wanted:
  - Collector area
  - Storage volume
  - Hydraulics without any hygenical problems

Example

- Category of the enterprise
  - 3 star hotel, 100% breakfast
  - Maximum number of beds: 40
  - Overnight stays from May to August: 3.800
  - Number of days from May to August: 123
- Personal hot water consumption per day
  - Hot water consumption: approx. 40 l/Tag and person (60°C)
  - Breakfast (100%): approx. 2l per guest (60°C)
  - Entirely: VGast = approx. 42l (60°C)
- Middle summer occupancy rate of utilization (May until August)
  - Occupancy rate = number of beds / (number of days x number of beds available) = 3.800/(123 x 40) = 0,77
- Average daily consumption of hot water (May until August)
  - Average daily consumption of hot water = VGast x occupancy rate x number of beds = 42 x 0.77 x 40 = 1,290 l/60°C and day

Example:



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Example:

3 star hotel
Maximum number of beds: 40
Overnight stays from May to August according to information: 3.800
Number of days from May to August: 123
Determination of the collector surface for hot water preparation for a solar covering degree of approx. 75 % during the summer months.

Determination of the collector area:

Occupancy rate: 16 ltr with 60°C per day / m² coll. area, hot water consumption 1.290 ltr with 60°C

$$\frac{\text{1290 liter with 60°C per day}}{\text{16 liter with 60°C per day / m² coll. area}} = \text{80 m² coll. area}$$

Determination of the solar storage volume:

Solar storage volume = A_{coll} [m²] * 60 [liter/m²] = 80 * 60 = 4.800 liter

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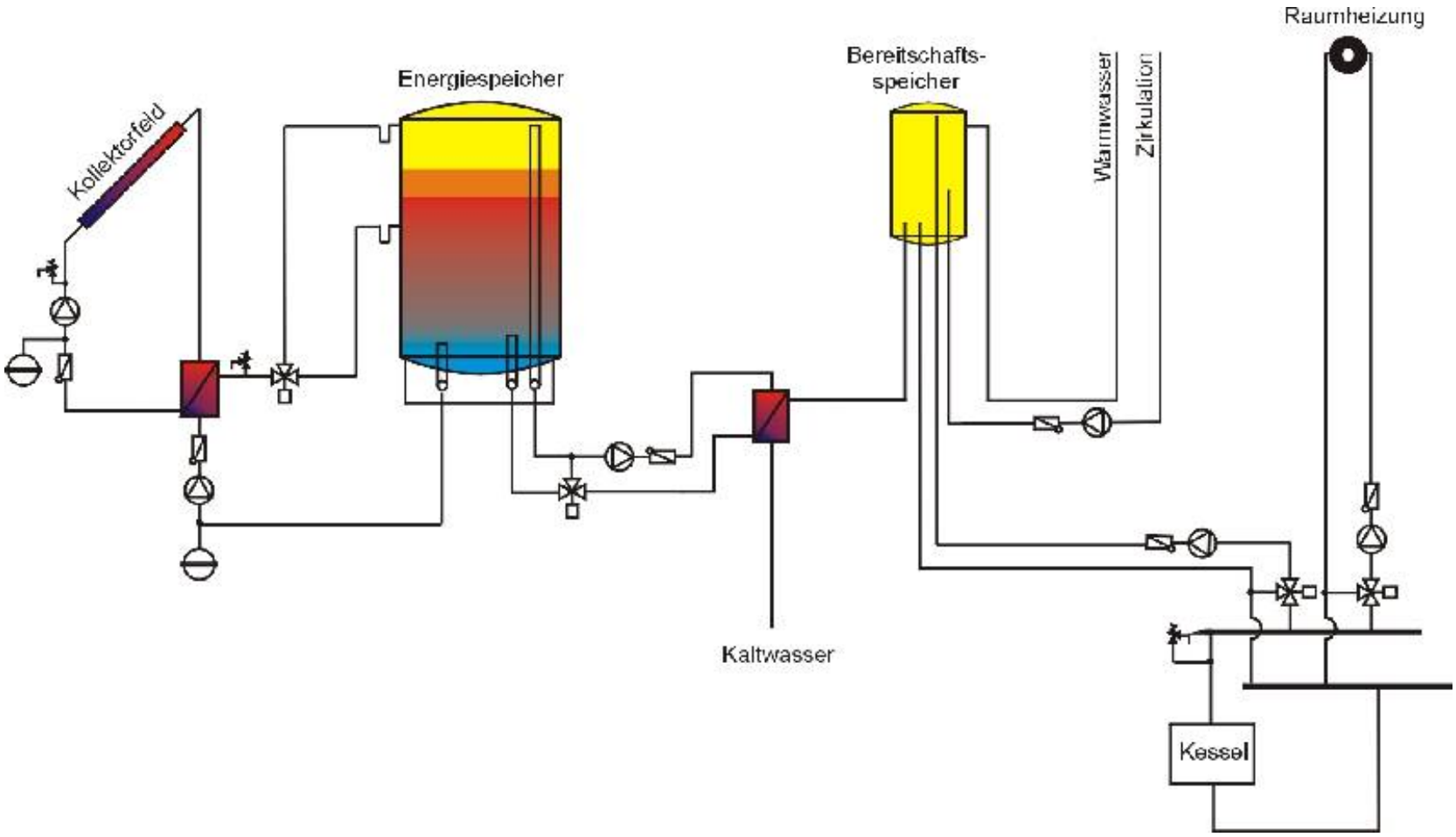
Example



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Determination of the volume which needs to be kept on a minimum temperature

In toursim 2 other characteristics are important:
- **additional heat needed to heat up the storage**
- **volume kept on a minimum temperature**

$$V_{eff} = V_{Guest} \times n \times h_{1,0} + Q_{zirk} \times 50\ ltr/kW$$

V_{eff} .....effektive hot water storage volume
n.....number of beds
$h_{1,0}$.....maximum peak per hour in percent of daily demand (seldom over 25-30% of the total demand
Q_{circ} .....load of the circulation pipe

	Max. hourly peak h1,0	Average hourly peak h1,0
Youth hostel, bed and breakfast, small hotel	22 %	15 – 18 %
Cityhotel	25 %	15 – 18 %
Seminarhotel	30 %	20 – 25 %

Example:

3 star hotel
Maximum number of beds: 40
Overnight stays from May to August according to information: 3.800
Number of days from May to August: 123
Determination of the collector surface for hot water preparation for a solar covering degree of approx. 75 % during the summer months.

Determination of the volume which needs to be kept on a minimum temperature

$V_{eff} = V_{Guest} \times n \times h_{1,0} + Q_{circ} \times 50$ ltr/kW.....effektive hot water storage volume

$Q_{circ} = (L_{circ} \times 10$ W/m) = 100 m x 10 W/m
= <u>1.000 W = 1,0 kW</u>

V_{eff} = 42 liter x 40 beds x 0,25 + 1,0 kW x 50 ltr/kW
= <u>470 liter</u>

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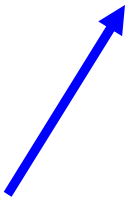
Example:

3 star hotel
Maximum number of beds: 40
Overnight stays from May to August according to information: 3.800
Number of days from May to August: 123
Determination of the collector surface for hot water preparation for a solar covering degree of approx. 75 % during the summer months.

Determination of the volume which needs to be kept on a minimum temperature

$V_{entirly} = V_{eff} / 0,75 = 475/0,75 =$ **635 liter** .....entirly hot water storage volume

$Q_{additional\ heating} = (V_{eff}/3600) \times c_p \times (T_{WW} - T_{KW}) + Q_{circ}$
$= (475/3600) \times 4,2 \times (60 - 10) + 1,0$
$=$ **28,7 kW → 29 kW**



- **Min. power between heat exchanger and the storages**
- **Average volume in the energy storage which needs to be provided by the producer**
- **Installed producer needs to have at least the power that the storage volume can be heated up within one hour**

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Thank you for your attention!

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