New application fields by solar thermal systems

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arsenal research

Table of content

- State of the art
- Plant hydraulics of combined solar systems in large applications
  - 2 pipe system
  - 4 pipe system
- Building integration
- Some impressions – the good, the bad, the ugly

State of the art

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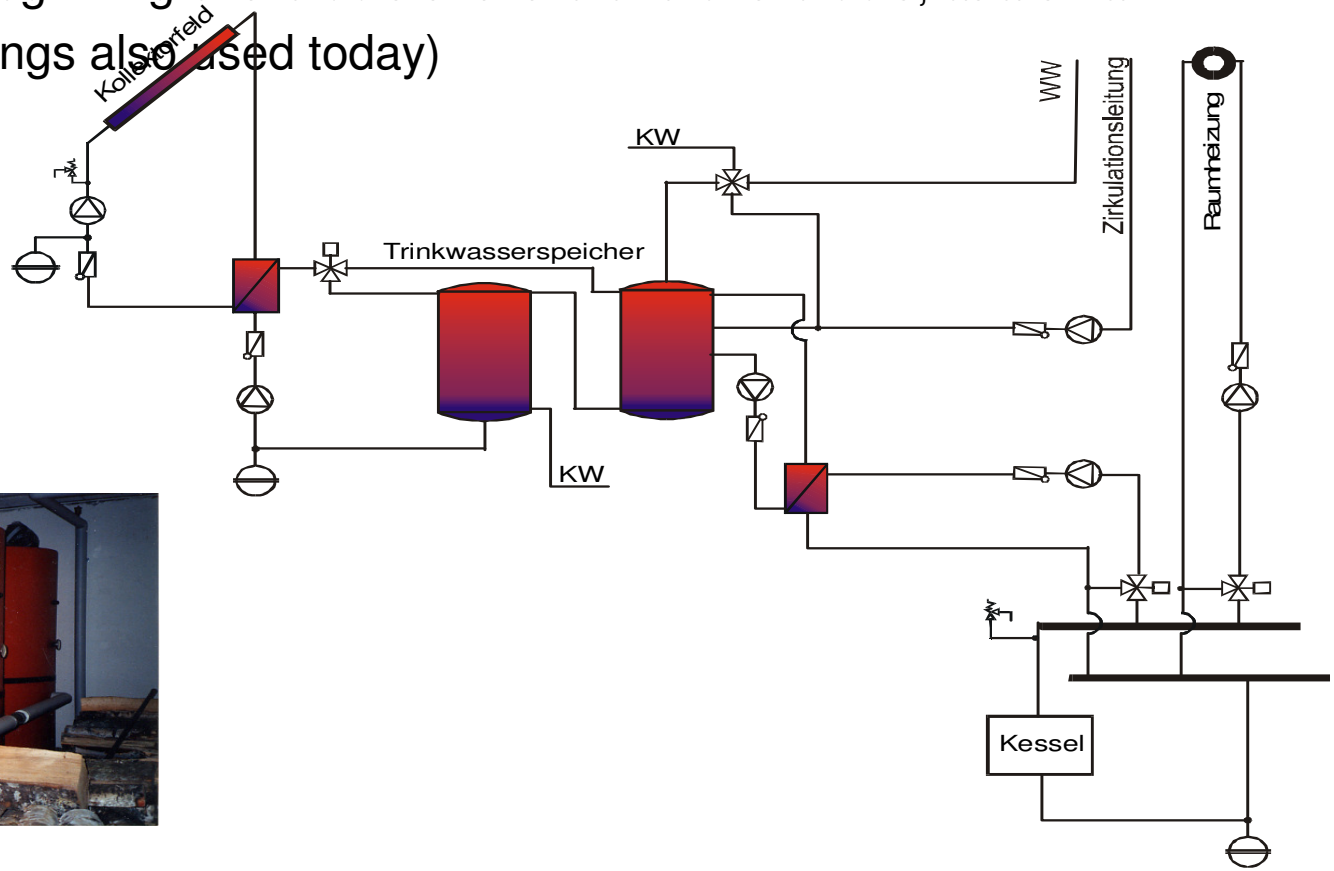
Development of combined solar systems

- Combined solar systems of the 1st generation in Austria

  (Started at the beginning of the 90's until the end of the 90's, at a small number of dwellings also used today)



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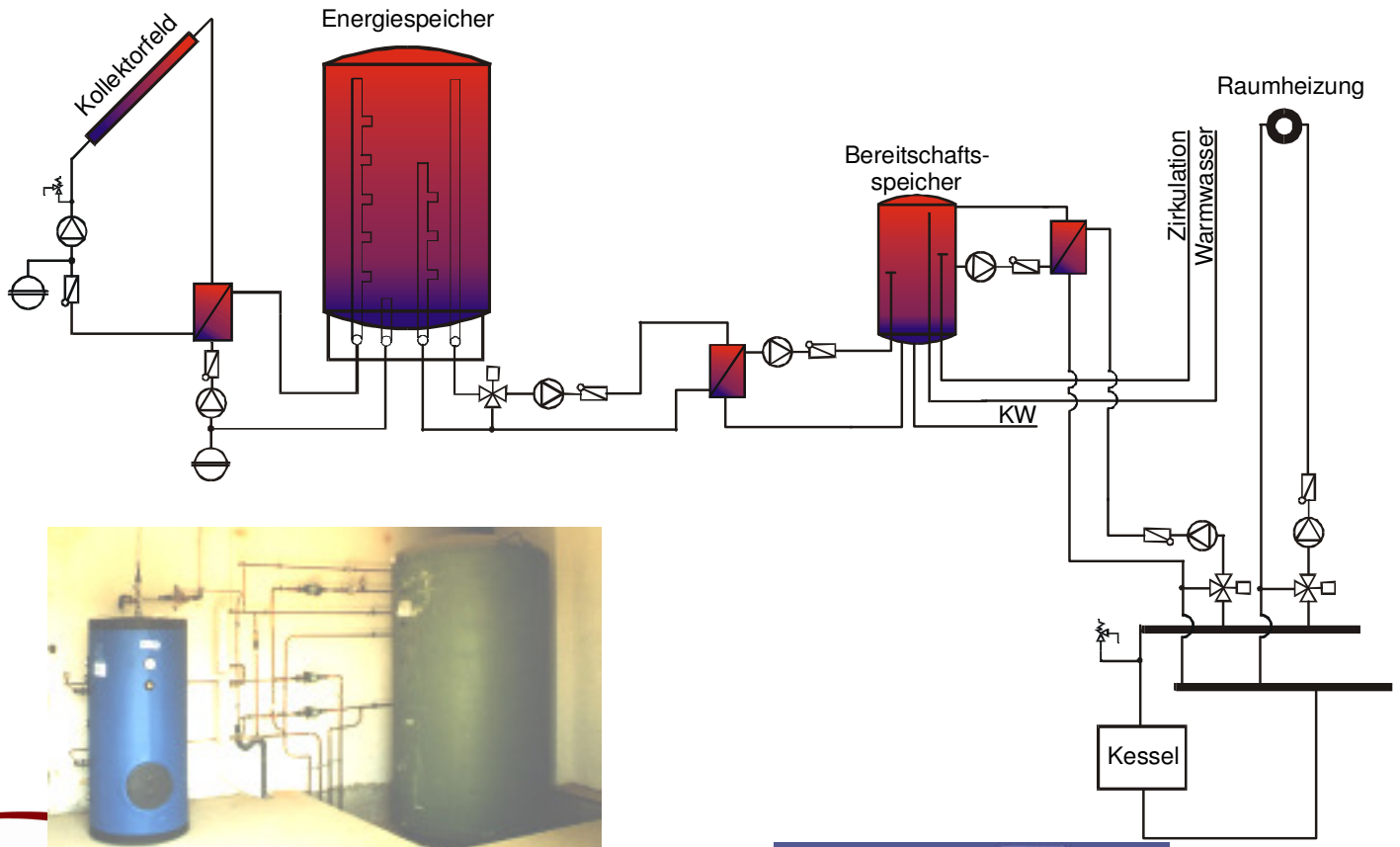
Development of combined solar systems

- Combined solar systems of the 2nd generation in Austria

  (Started in the middle of the 90's until today)



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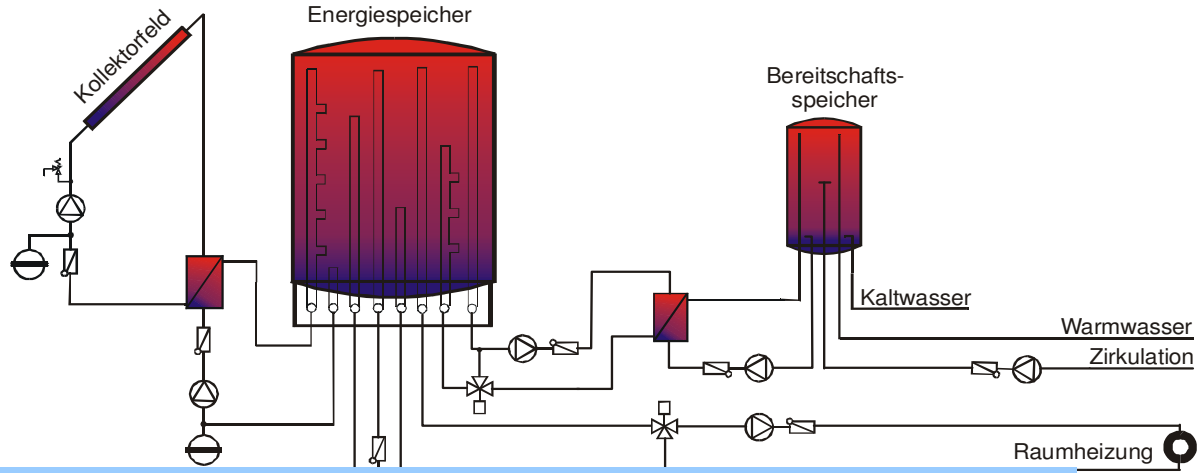
Numerous results of measurement showed….

- Solar supported distribution nets of the 1st and 2nd generation are not always working as efficiently as they should (losses!)
- Return temperatures are usually very high

Heat producer up to 20%

Heat storage up to 30% of the total heat demand

Heat distribution up to 40%



⇒ **low annual system performance (often 30 to 40%)**

⇒ **low specific solar gains and covering degrees**

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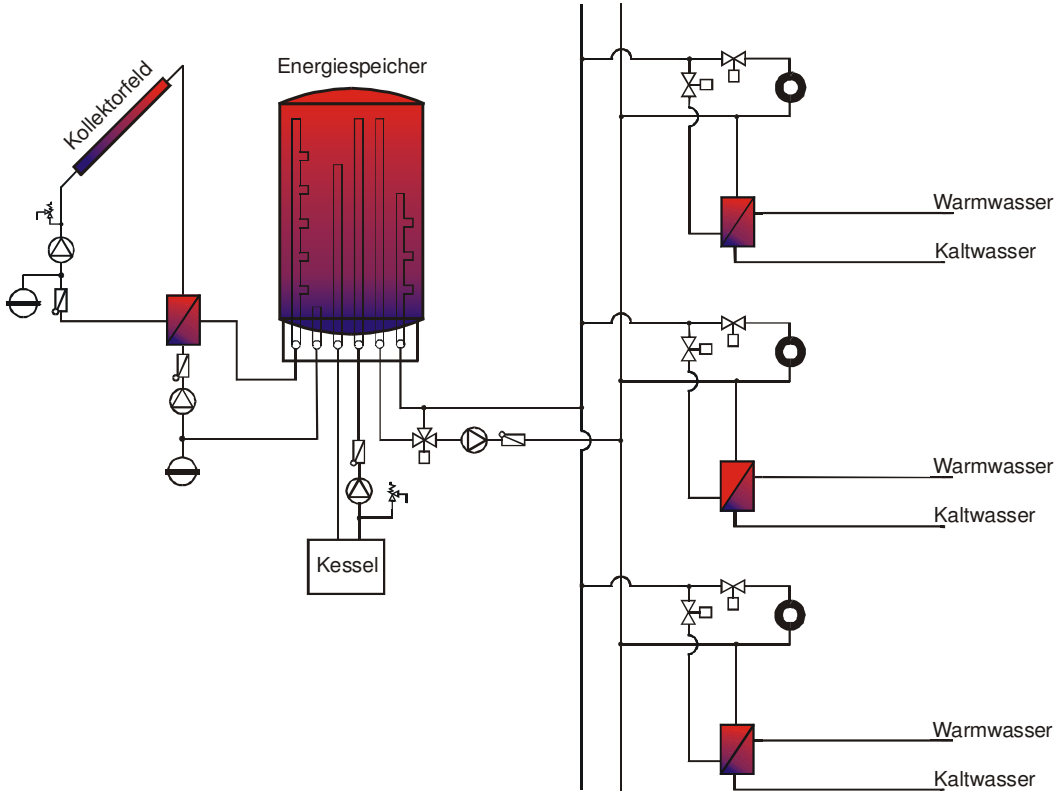
Requirements of solar supported heat distribution nets of the 3rd generation

- Holistic systems
- Adapted basic conditions for the use of solar systems
- Conceptional reduction of calorific losses
- Highest comfort for occupants
- Hygienically harmless drinking water heating up
- Economically meaningfully
- Modern control of operating
- Apart from the employment in new buildings an employment in existing buildings must be possible

2-pipe systems can absolutely fullfill these requirements!

Plant hydraulics of combined solar systems in large applications



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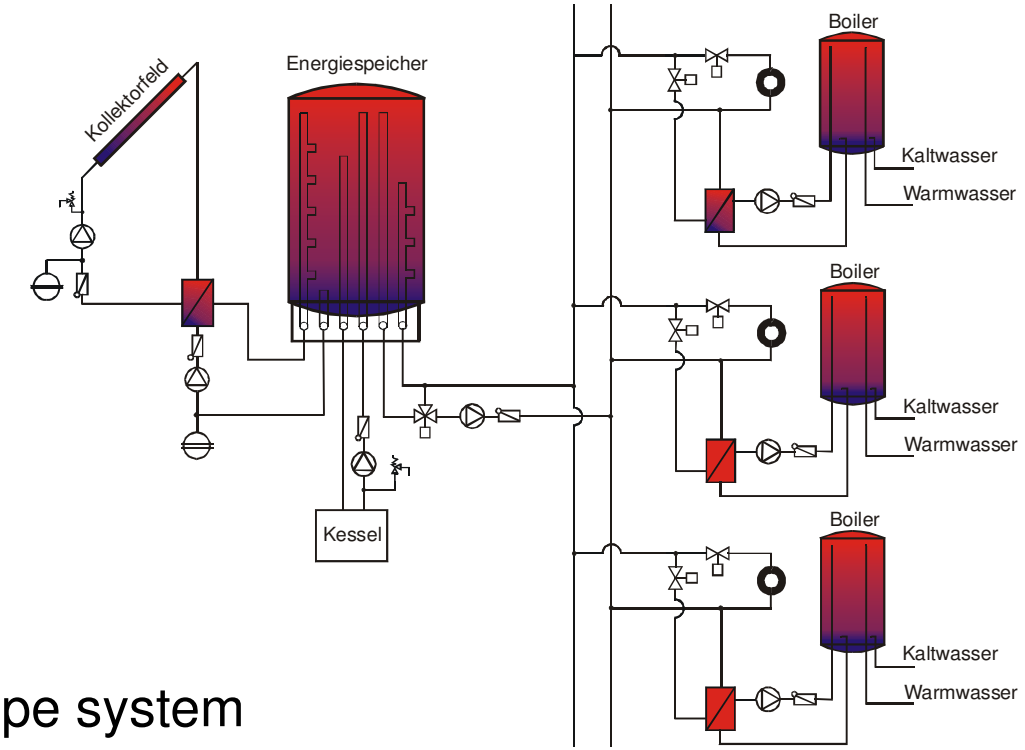
Solar supported heat systems of the 3rd generation in Austria



- Heat distribution from a 2-pipe system
- Hot water heating with a decentralised storage
- Meaningful employment with small energy densities

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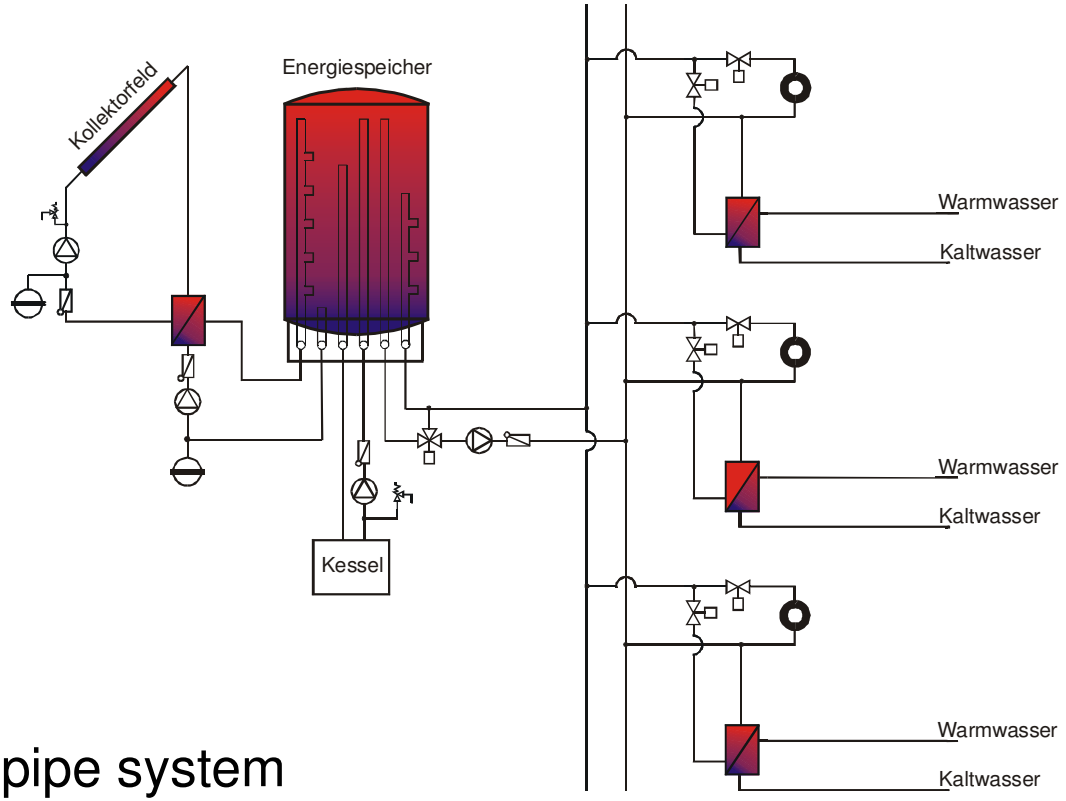
Solar supported heat systems of the 3rd generation in Austria



- Heat distribution from a 2-pipe system
- Hot water heating in a decentralised flow principle
- Meaningful employment with small and high energy densities

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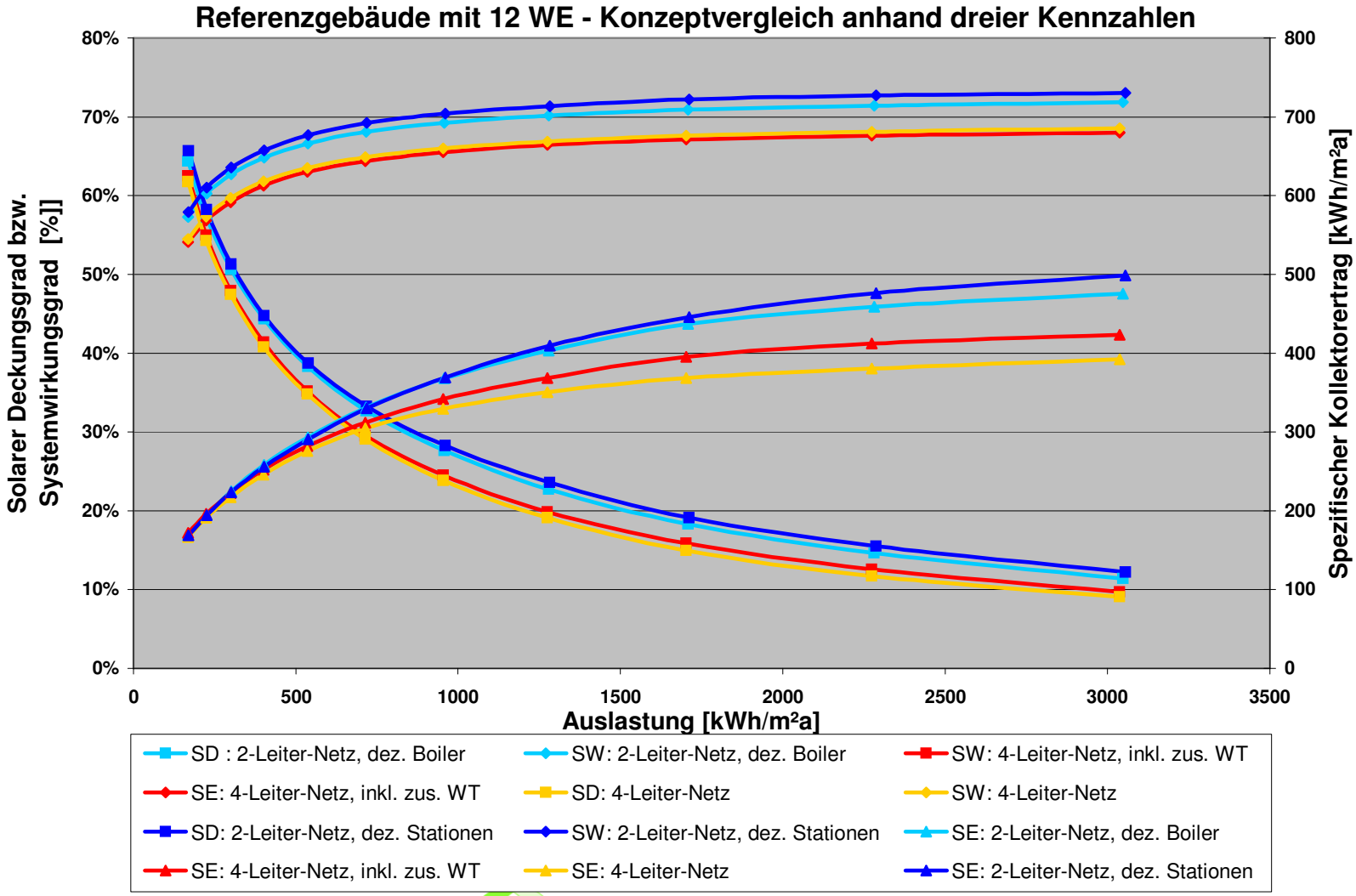
Advantages of 2-pipe systems



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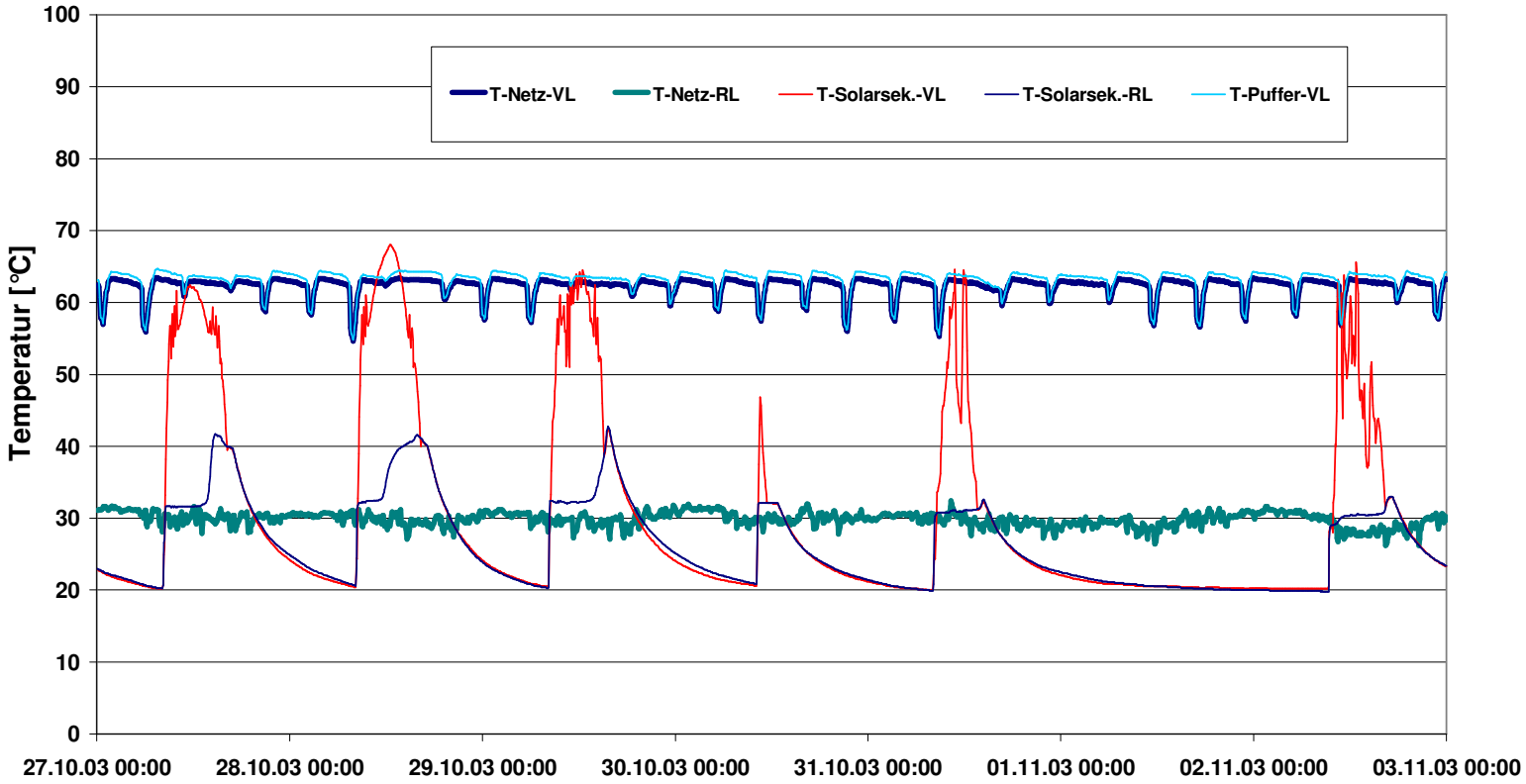
Advantages of 2-pipe systems

- Return is nearly constant at 30°C and offers best conditions for the use of solar thermal systems



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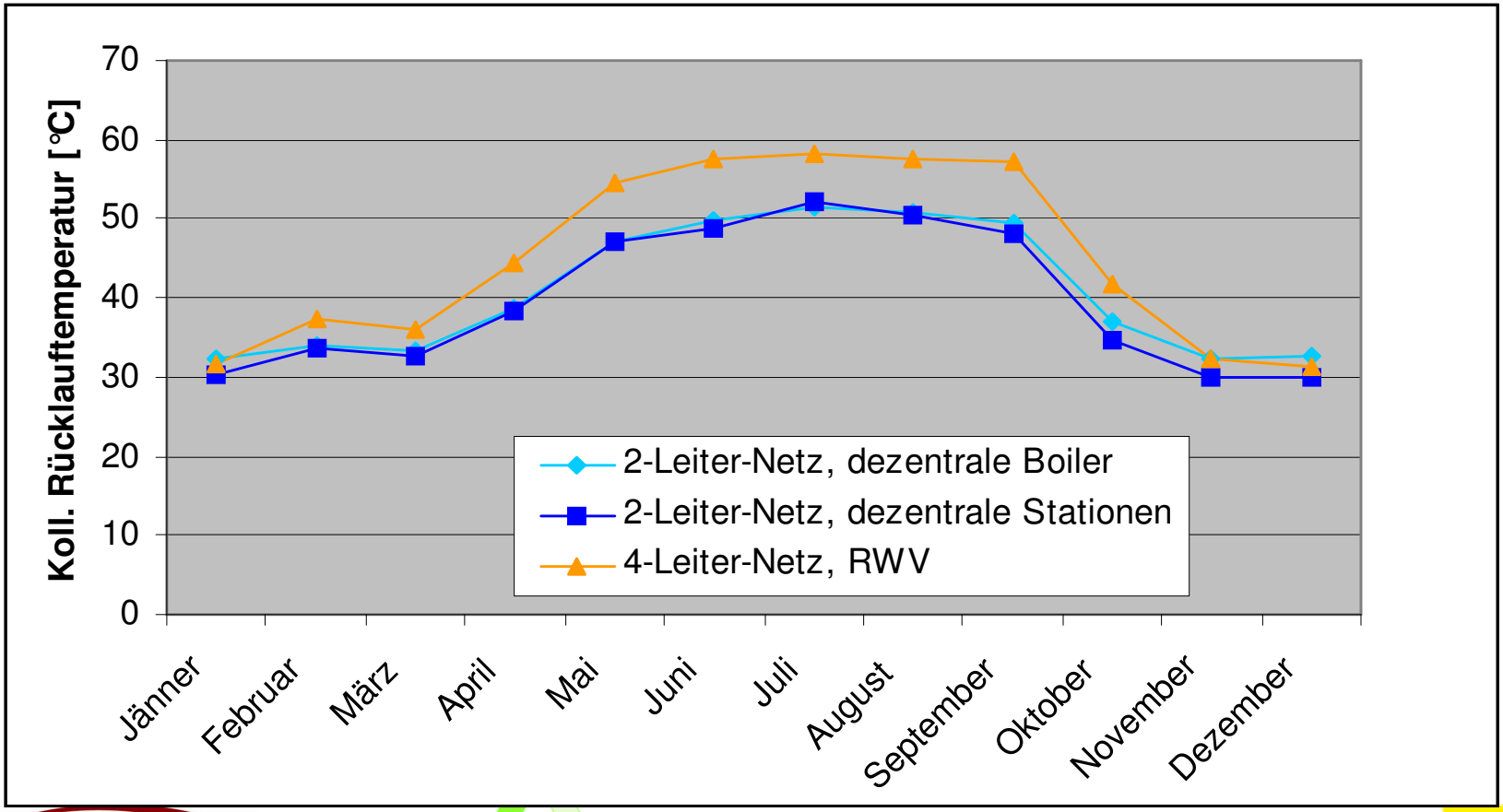
Advantages of 2-pipe systems

- Comparison of annual return temperatures of three different systems, 12 units, 20% solar covering degree

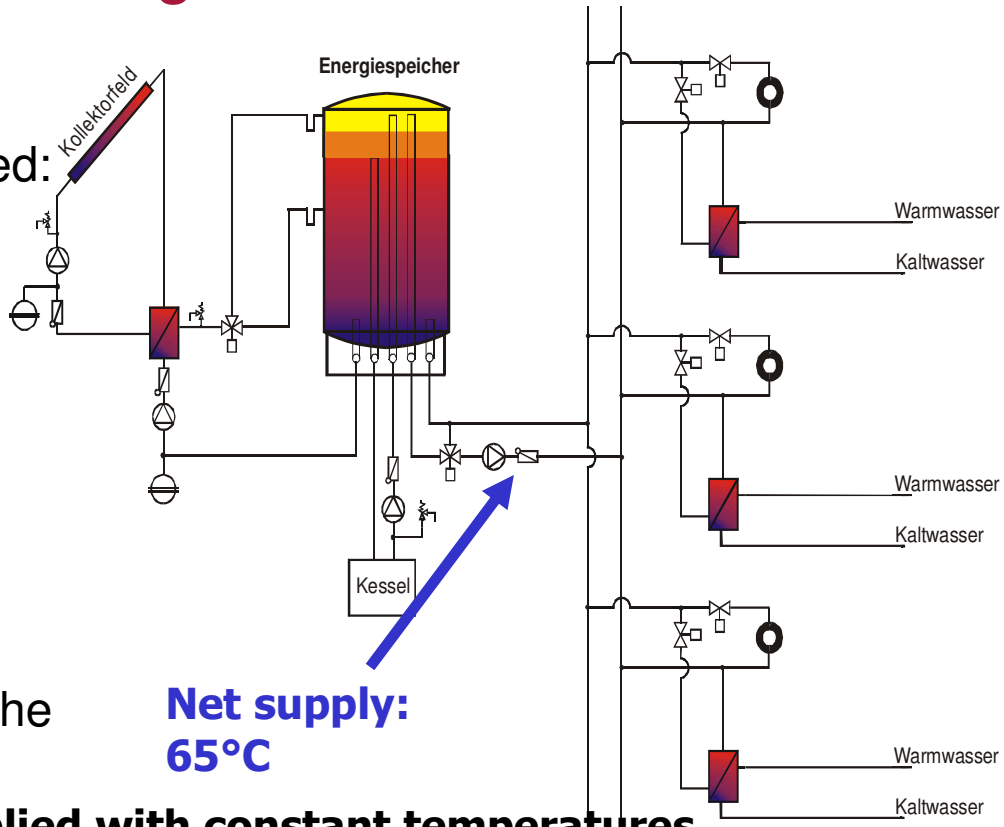


Advantages of 2-pipe systems

- Distribution losses are set to a minimum
- Because of the system a automatically heat support can be achieved
- Extensive tests show cheaper heat prices compared to 4-pipe systems
- A gain in comfort and absolutely harmless water hygiene
- Reduction of the error frequency in industrial manufactured substations and no auxiliary energy is needed

Solar supported energy distribution nets: 2-pipe systems with decentralised district heating substations

- Solar system
  - If an energy storage is integrated:
    - > Operational mode: Low (Matched) Flow
- Conventional boiler:
  - Feeds into the energy storage
- Heat distribution:
  - With a pair of pipes (2 pipes)
- Hot water preparation:
  - Decentralised flow principle in the flat



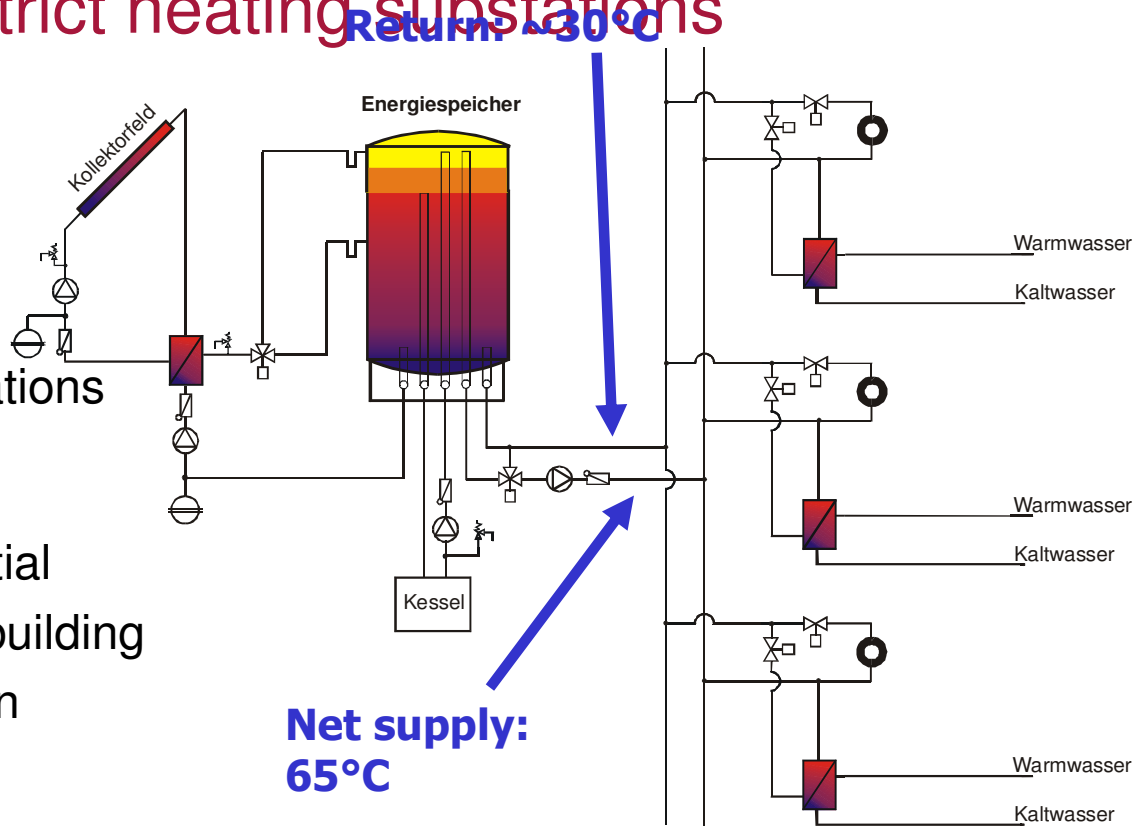
<u>Important</u>: The distribution net is supplied with constant temperatures (approximately 65 °C) during summer and winter

<u>Important</u>: the upper part of the storage needs to be kept on a minimum temperature (65°C) →security of support

<u>Important</u>: Heater dimensioning 65/40

Solar supported energy distribution nets: 2-pipe systems with decentralised district heating substations

- Important components:
  - Mixing valve
  - Pump
  - District heating substations
- Application:
  - New building, residential buildings in compact building method, reconstruction



Advantage: The hole year low return temperatures of approximately 30°C → few distribution net losses

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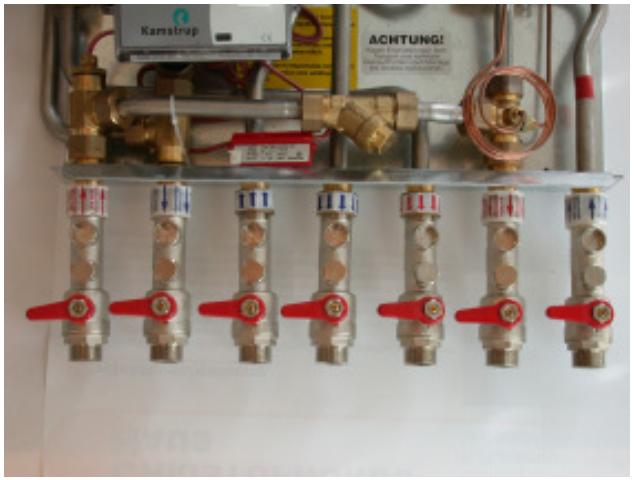
Substations

- Advantages of substations:
  - Industrial manufacturing
  - Highest quality criteria
  - No external energy requirement
  - Low investment costs
  - Individual design (finery, in the wall, different geometry)



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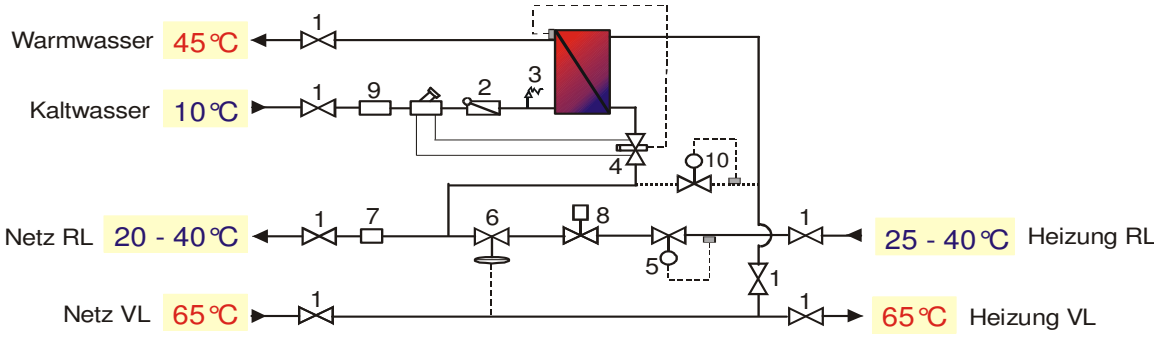
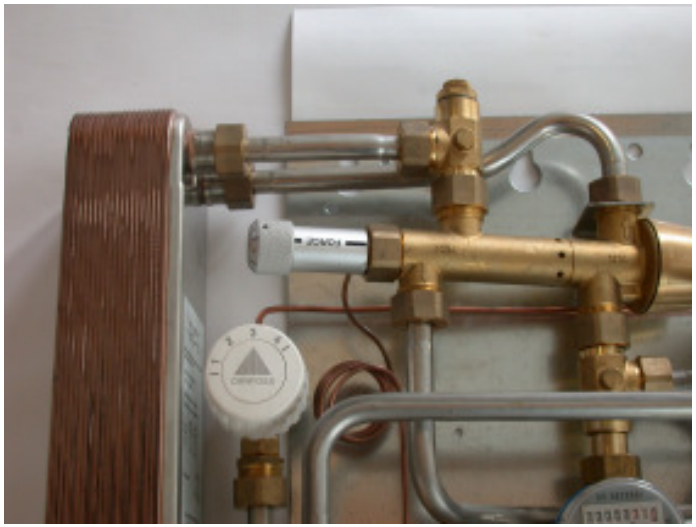
Functions of substations



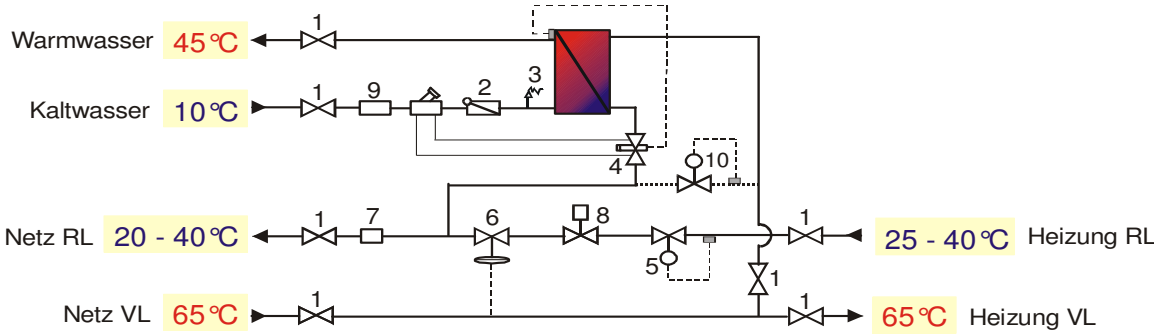
1 Absperrventil
2 Rückschlagklappe
3 Sicherheitsventil
4 Durchflussgesteuerter Temperaturregler
5 Rücklauftemperaturbegrenzer
6 Differenzdruckregler
7 Zählerpassstück
8 Zonenventil
9 Passstück Kaltwasser
10 Zirkulationsbrücke



All components for decentralized hot water heating and space heating are contained

- Important components for hot water preparation:
  - Plate heat exchanger: hot water is produced when its needed
    - > Small risk of legionella
    - > Highest hygiene
  - Proportional controller: regulates the hot water temperature and adapts the flow rate to the hot water consumption
    - > No calcification because of the temperature limit

Functions of substations



- Important components for heat preparation:
  - Differential pressure regulating valve: hot water is produce when its needed
    - > Provide a constant mass flow in individual units of the dwellings
    - > Inappropriate adjusting can be prevented by fixed pre-setting
  - Return controller: are used in the return and fixed on 40 °C
  - Thermostatic valve: control the temperature in the units

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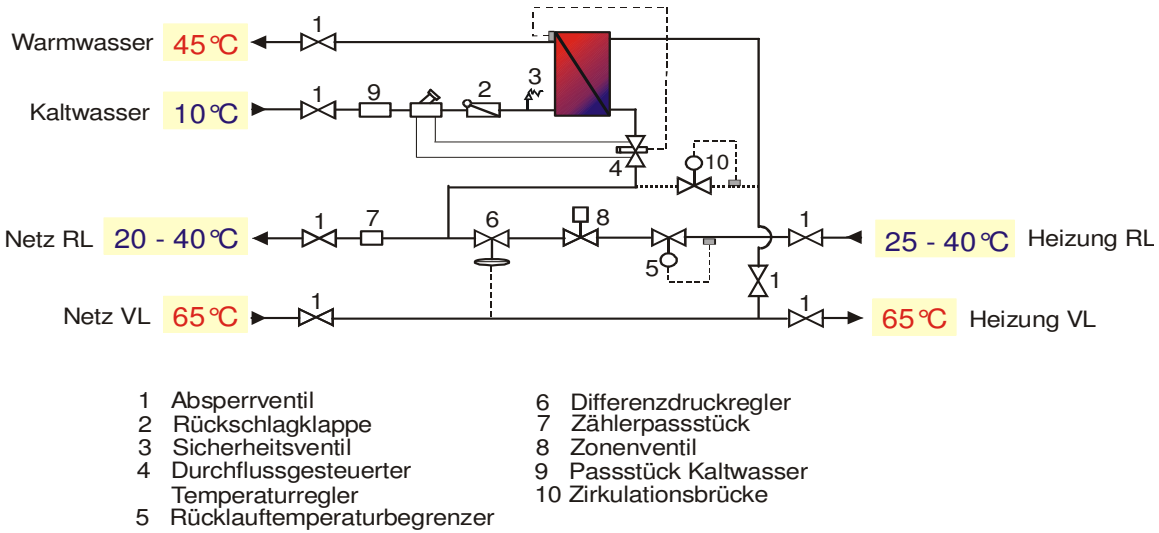
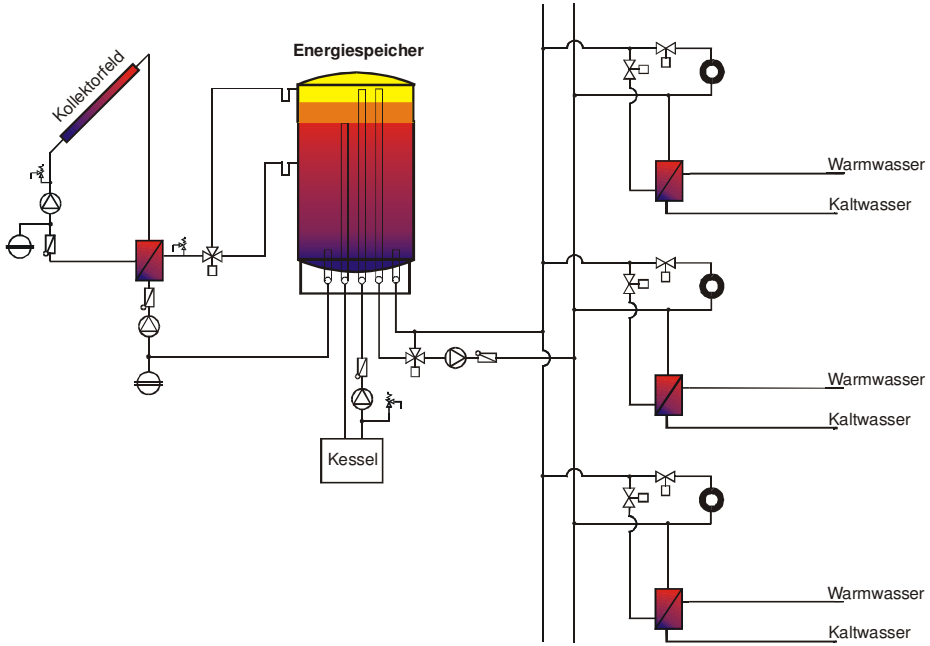
Measuring devices of substations



- Important components for measuring the demand:
  - Water meter
    - > measures the total amount of hot water used in a unit
  - Heat meter
    - > measures the total amount of hot water and heat used in a unit
  - Can be read out manually or via a bus-sytem

Distribution net

- Characteristics of 2-pipe systems with substations
  - Strongly varying flow due to the decentralized hot water preparation
  - Constant flow temperatures over an entire operational year



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Distribution net

- Volume flow
  - Between summer and winter varying volume, usage of two pumps:
    - > Pump for summer
    - > Pump for winter
    - > Reduction of the needed electricity
  - Ascending pipe needs to be regulated correctly, usage of a differential pressure regulating valve
  - Mixing valve: temperatures up to 95 °C during summer mean highest requirements on the mixing valve

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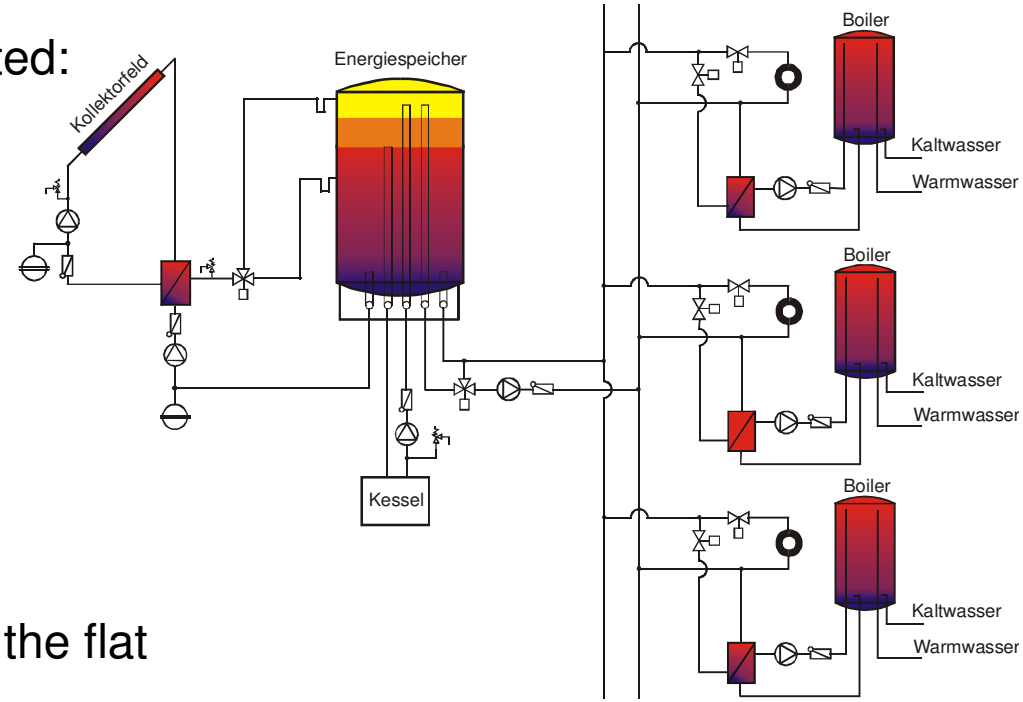
Solar supported energy nets: 2-pipe systems with decentralised hot water storage

- Solar system
  - If an energy storage is integrated:
    - > Operational mode: Low (Matched) Flow
- Conventional boiler:
  - Feeds into the energy storage
- Heat distribution:
  - With a pair of pipes (2 pipes)
- Hot water preparation:
  - Decentralised flow principle in the flat



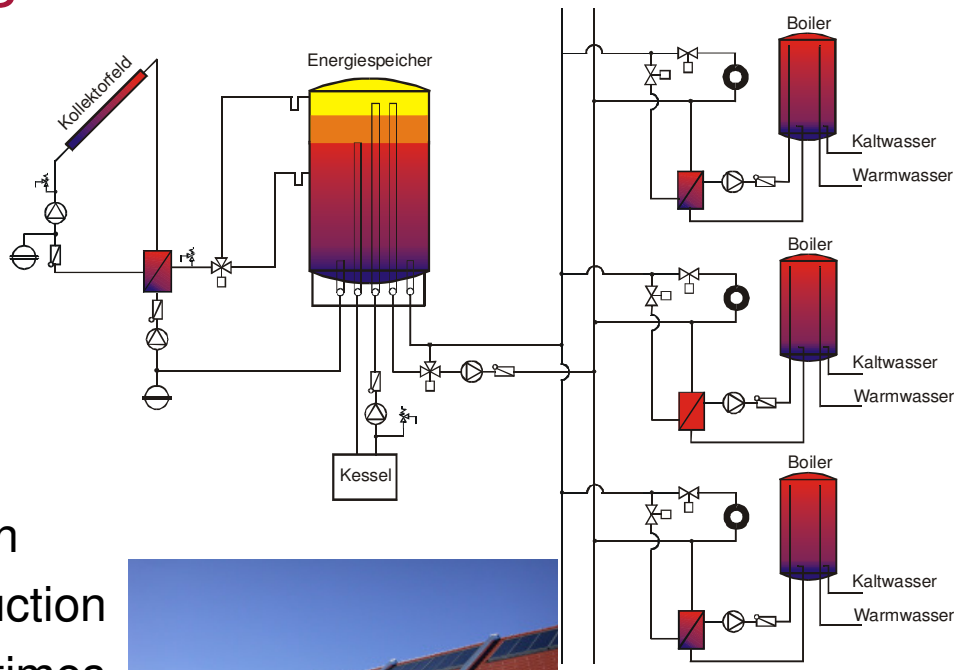
<u>Important</u>: The distribution net is used 22h to 23h for the heat supply and just 1h to load the boiler

<u>Important</u>: the upper part of the storage needs to be kept on a minimum temperature (65°C) →security of supply

<u>Important</u>: Heater dimensioning 65/40

Solar supported energy nets: 2-pipe systems with decentralised hot water storage

- Important components:
  - Mixing valve
  - Pump
  - Decentralized load substations
- Application:
  - New building, residential buildings in compact building method, reconstruction (already existing devices can sometimes be further used)

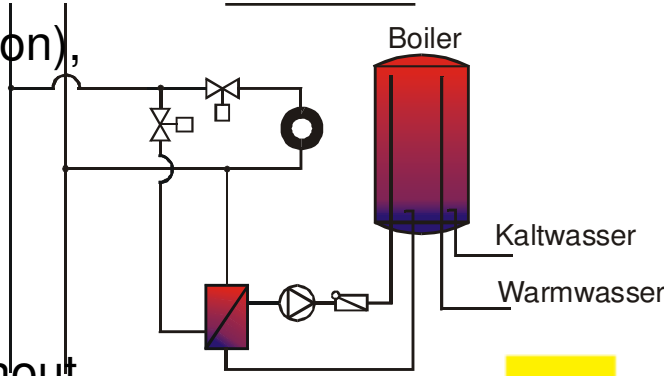


Advantage: Low return temperatures from the beginning of the boiler load

Advantage: Distribution losses are reduced during summer (pipes are heated up just once/day)

Hot water preparation / Space heat supply

- Hot water storage:
  - Dimensioning on a daily use of 150-200 litres
  - Placement: storage, toilet, bath, possibly cellars
    - > Importantly: short ways to the taps
- Loading of the hot water storage:
  - external heat exchangers
    - > Deep return temperatures can be obtained
    - > Importantly: hydraulic uncoupling
- Loading:
  - Low loads, irradiation-strong time periods (at noon), load duration (1h)
- Space heat supply:
  - Dimensioning of radiators on a max. 65/40°C
  - Usage of low temperature systems possible without any problems



Summary

2 pipe systems with substations

Application:
- new buildings
- reconstruction
- dwellings and terraced houses

Advantages:
- low investment costs
- hygienical hot water preparation
- compact
- low required space
- low distribution losses
- amount of hot water is unlimited
- comfort

Disadvantages:
- pump is used the whole year
- operating current

2 pipe systems with decentralized hot water storage

Application:
- new buildings
- residential buildings in compact building method
- reconstruction

Advantages:
- heats up the distribution net just once a day (low distribution losses)
- hygienical hot water preparation

Disadvantages:
- higher investment cost because of the decentraized hot water storage
- more space is needed

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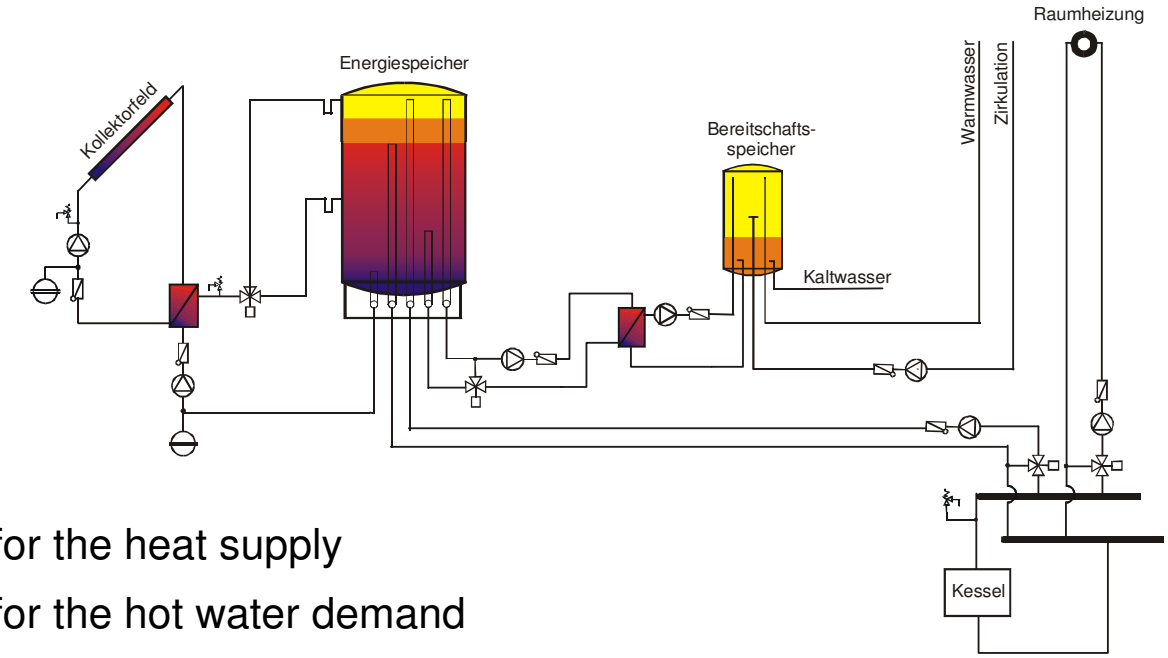
Solar supported 4-pipe systems

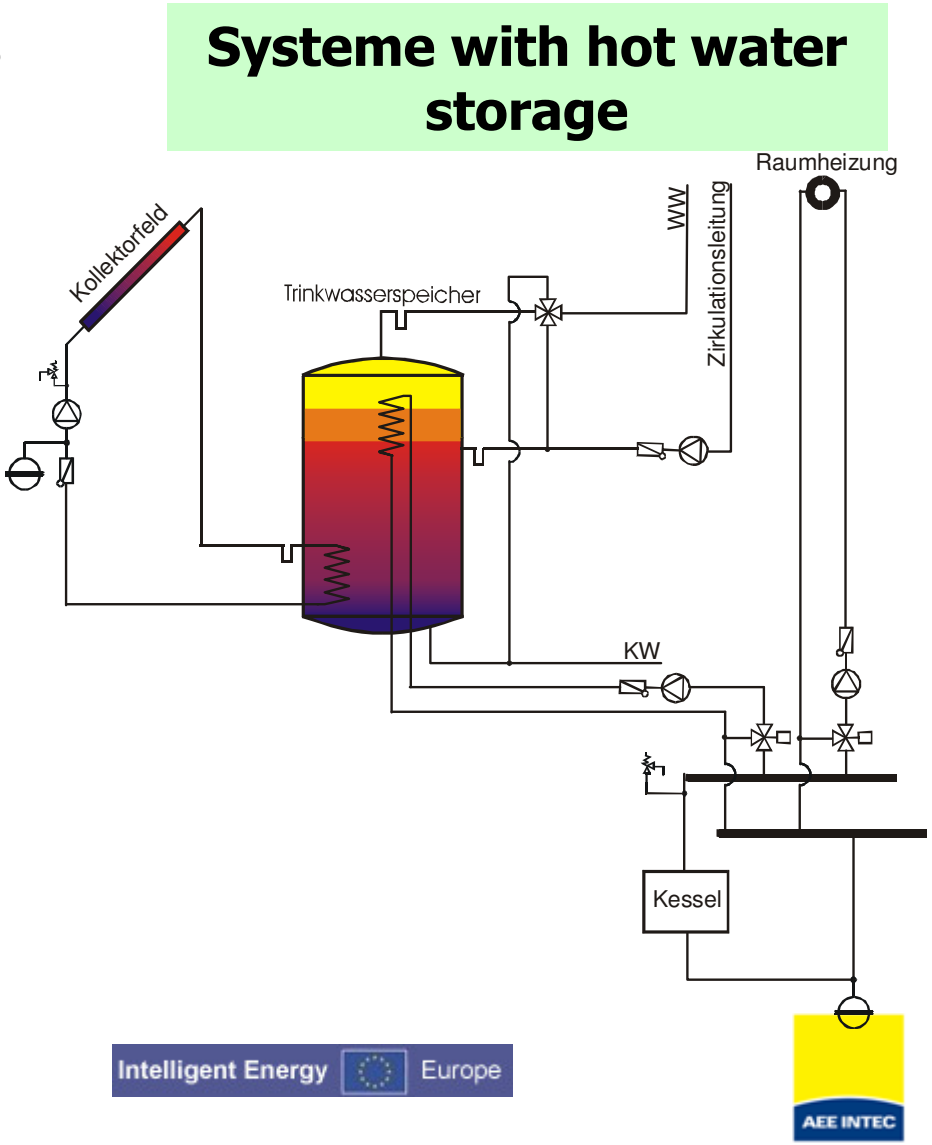
- Application
  - Reconstruction of buildings with already existing central hot water distribution



- Functions:
  - One pair of pipes for the heat supply
  - One pair of pipes for the hot water demand
- Separation in:
  - Systems with one storage (max. 10 units)
  - Systems with two storages (larger dwellings)

4-pipe system with hot water storage

- Application: for a maximum of 10 flats
- Hot water storage
  - Cost-intensive by interior coating or high-grade steel
  - high requirements on water hygiene
- Integration of the solar system
  - Internal heat exchanger
  - Plate heat exchanger
- Temperature delimitation of the storage on 60°C: Calcifying danger of the external heat exchanger



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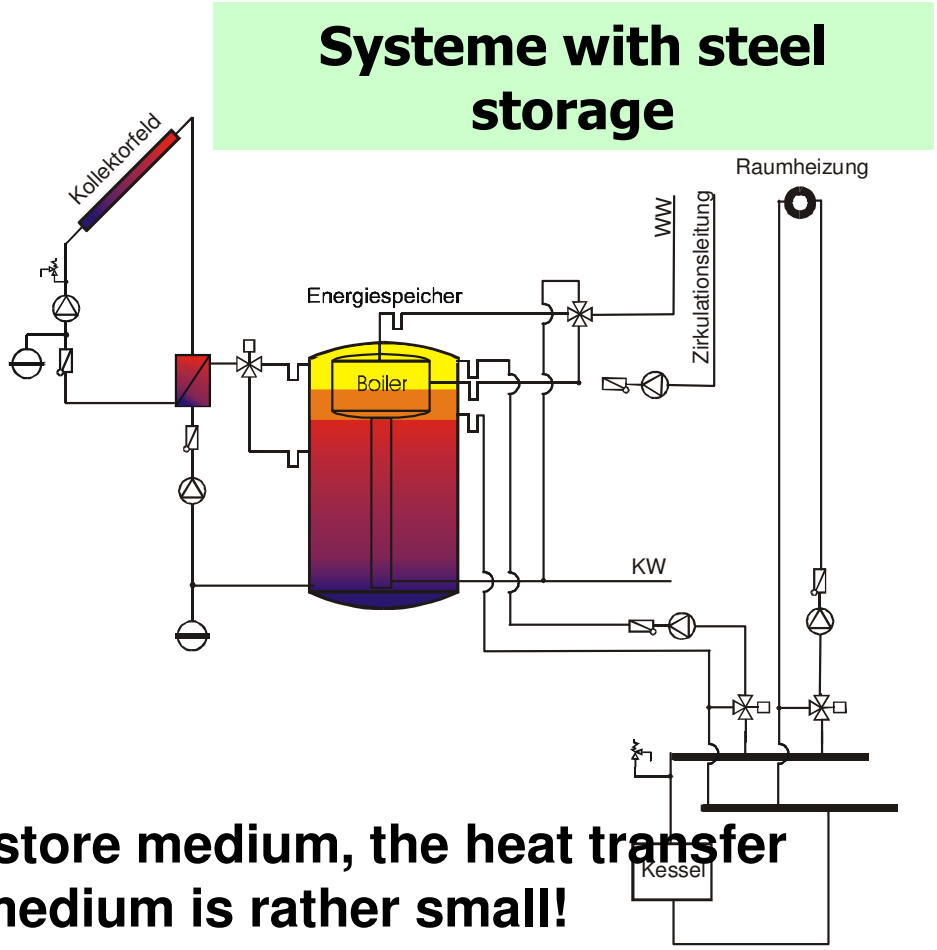
4-pipe system with one steel storage

- Steel storage
  - Is used as energy storage
- Integration of the solar system
  - Internal heat exchanger
  - Plate heat exchanger
- Hot water preparation
  - Internal water storage
  - Internal tube heat exchanger

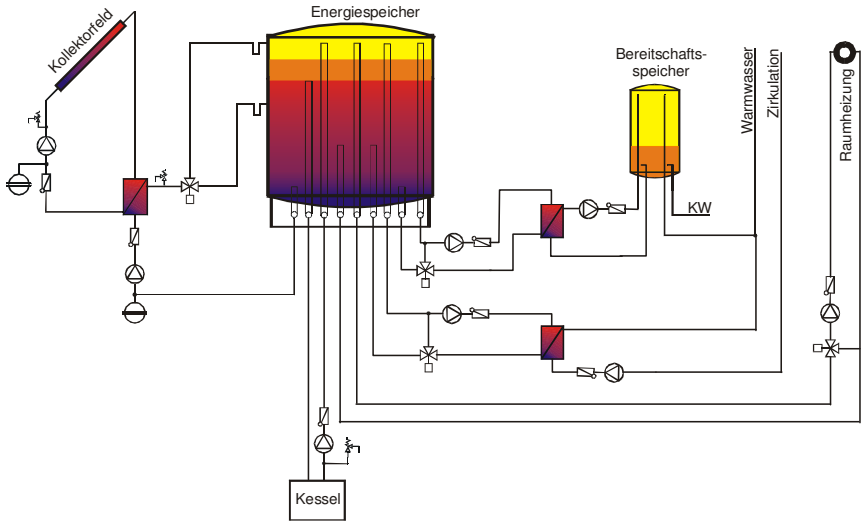


Because of the standing energy store medium, the heat transfer between hot water and storage medium is rather small!

Supply security is ensured by the provision of a large amount of hot water and large boiler or tube heat exchanger area

4-pipe system with two-storage systems

- Application
  - For large hot water consumption



- Layout
  - Central energy storage (steel), Central hot water storage to cover peak loads
  - Conventional heat generator feeds exclusive in the energy storage
  - Energy storage supplies the space heating

Increased solar results up to 10% compared to solar systems for the hot water preparation -> should be included in heat heating system!

Sometimes old storages can be used!

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Ranges of recommended angles of inclination and alignment of collector surfaces in dependence of the solar covering degree

Desired dimensioning	Solar covering degree	Recommended collector angle of inclination	Recommended collector alignment
Dimensioning in cost/use optimum	appr. 12%	25 to 40°	preferable South, tolerable deviation eastward 45° and the
	appr. 20%	30 to 45°	preferable South, tolerable deviation eastward 45° and the west 45°
Dimensioning with 100% summer covering	appr. 28%	40 to 55°	preferable South, tolerable deviation eastward 45° and the west 45°

- Building Integration

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Potential

- New buildings
- Old buildings / redevelopment
- Requirements for architects

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Architecture – New buildings

- design flexibility
  - Integration
  - Presentation

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Architecture – Old buildings / redevelopment

- design flexibility

  – „After war buildings“ of the 50ties to the 70ties

  – Combination with a redevelopment of the faacade

- Monumental protection
  - In the city
  - old part of town

Architecture - requirements

- Standard sizes
- Special sizes available
- Colored absorbers
- Colored cover strip
- Large surfaces

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Collector integration

- To take care of:
  - Variations in temperature (particularly by construction units closely linked to other parts of the building)
  - Bird-ate
  - Note!
    - > Life span of the roofing and/or the roof framing
    - > Weight - collectors 20-30 kg/m2
    - > Wind and suction forces

Facade integration

- Multiple use of facade collectors
  - Solar collector
  - Weather protection of the front
  - Design element
  - Noise control
- facade collectors with backing ventilation
  - no problems from the building design aspect

- facade collectors without backing ventilation
  - brings auxiliary use to thermal insulation
  - passive-solar element
- Advantages
  - Reduction of calorific losses
  - Cost saving by multiple use
  - small/no preservation work
  - Old building and new building-suited

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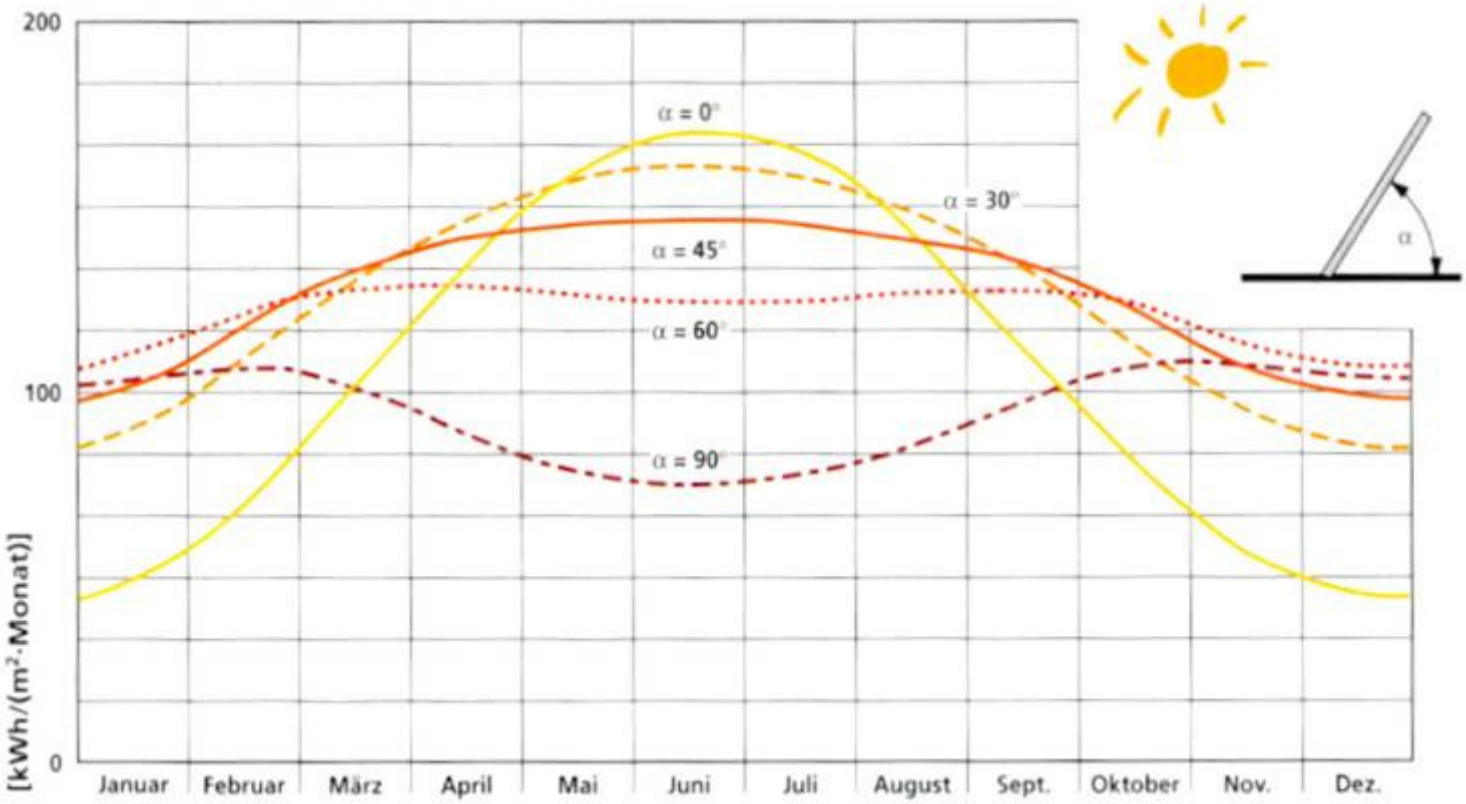
Adjustment and inclination of collectors

Yearly variation of the global radiation on inclined surface in kWh/m ², month



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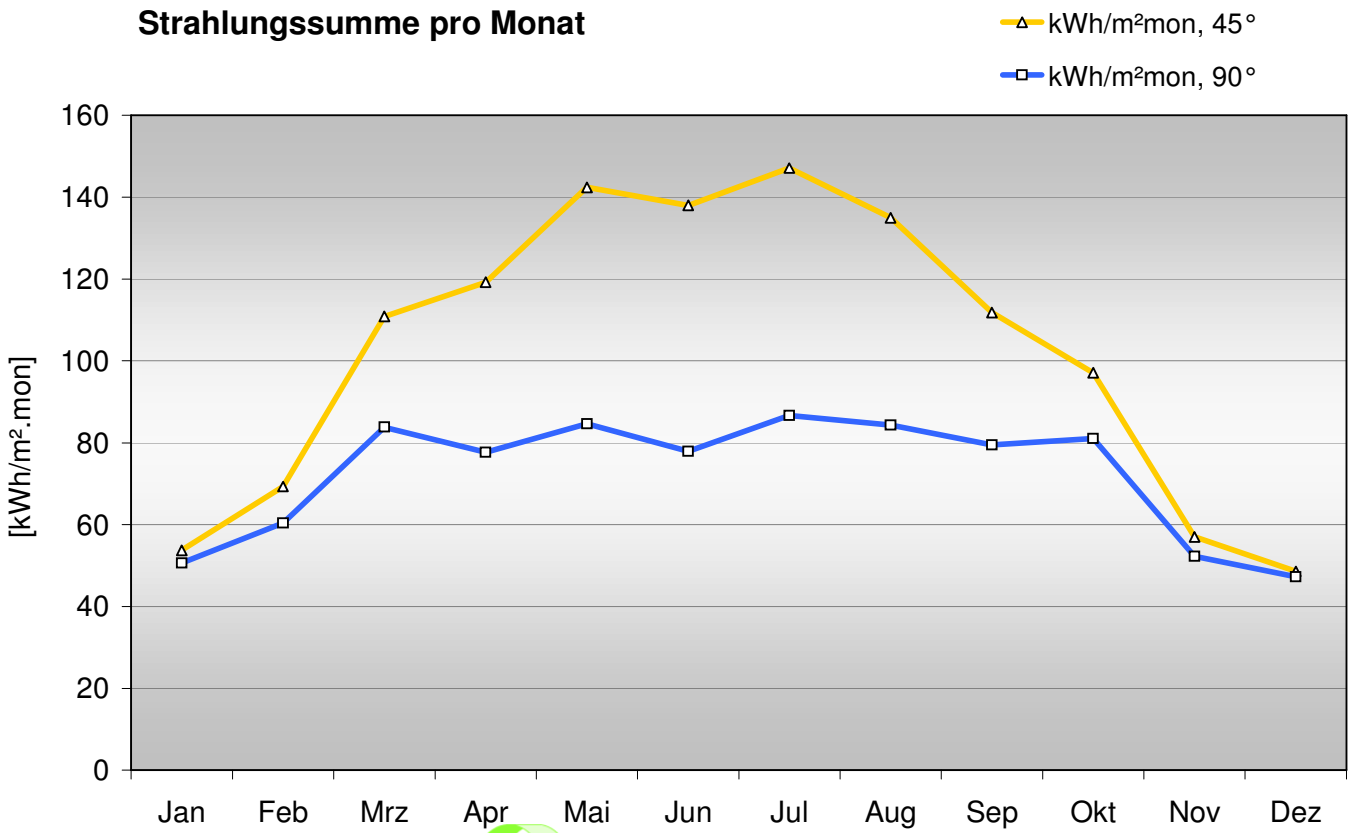
Irradiation in the facade

- Irradiation approx. 30% smaller than on inclined surface



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Colored absorbers

- smaller selective layer
- larger collector surfaces necessary

Enlargement of the collector surface

- With colored absorbers the surface must be increased between 20% and 70% to selectively coated absorbers
- Combined systems need less enlargement than plants for water preparation

Anlage	Solarer Deckungsgrad	Solarlack zu selektiv	Grün/blau zu selektiv	Rotbraun zu selektiv
	[%]	[m²/m²]	[m²/m²]	[m²/m²]
Einfamilienhaus, 4 Personen, WW-Bereitung	70	1,5	1,5	1,7
Einfamilienhaus, 4 Personen, WW-Bereitung und 8 kW Heizlast	40	1,2	1,3	1,4

Facade integration

- Costs
  - Collector surface must be increased
  - Piping more dificult
- Use
  - Reduced calorific losses
  - Saving of glass facade (if planned)
  - No preservation work (Painting…)
  - Noise control
  - Element architectural value

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the good, the bad and the ugly

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