Stahrsolar – Earning more efficiently

The Collector- Temperature- Model

Motivation and Target

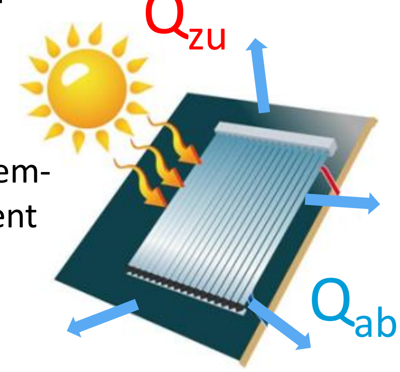
- For activation of solar pump/s measured collector temperatures are needed
- Measurement values are only representative for flowing media and deliver just local information
  - ⇒ are only evaluable with free or arbitrarily forced convection
    - ⇒ No or late solar start with excessive outlet temperature
  - ⇒ Thermal frost protection is only ensured with a steady collector flow
    - ⇒ High heat demand and auxiliary energy for frost protection of water-filled systems

Target: exact and current temperature value

Approach

Modeling of a global collector temperature T by means of energy balance

- Heat input (Q_{zu}) primarily by solar radiation
- Heat output (Qab) primarily due to temperature difference to the environment
- Each collector system has ITS heat transfer and ITS specific solar power



$$T = T_{-1} + dT\{Q_{zu}\} - dT\{Q_{ab}\}$$

Prototype

System:

- 11m² Vacuum tubes with water as carrier medium
- Secondary collector circuit (see Stahrsolar - The optimized variable hydraulics)

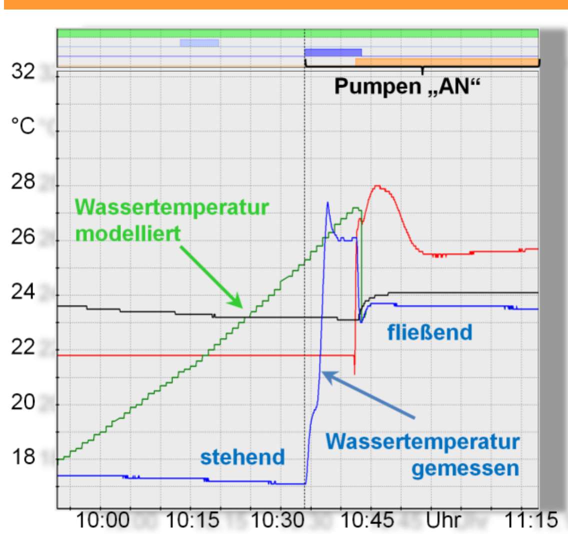
Metrology/sensors

- Collector and ambient temperature
- Solar radiation

Software/Functions

- Self-correcting temperature model
- Solar start and frost protection are performed via model temperature

Results



Current testing status :

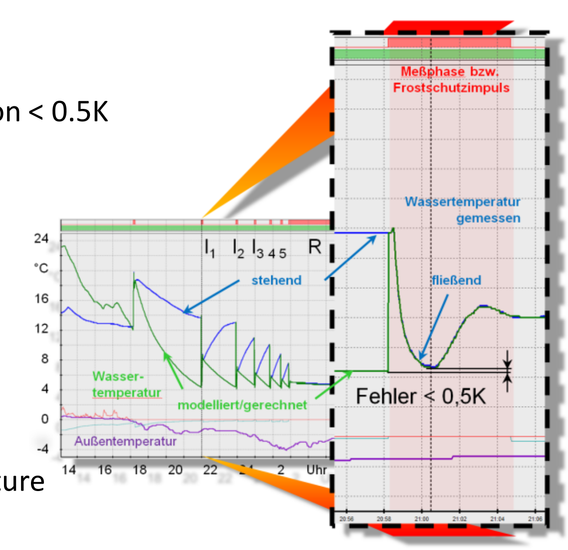
- Prototype running successfully since 2017
- Approx. 4 days after model start model deviation < 0.5K

Everyday benefit :

- Immediate earning with min. usable radiation
  - ⇒ Max. solar operating time / max. yield
- Rare activation of the frost protection
  - ⇒ Minimal need for antifreeze heat
  - ⇒ Very low auxiliary energy requirement

Function validation:

- System with flat plate collectors and glycol mixture
- Operator is surprised and very satisfied



Economic efficiency

- ➢ Low investment: sensors, control + installation
- ➢ Significant increase in yield with low radiation
- ➢ Cost or consumption reduction due to more efficient frost protection

⇒ **Amortization already possible in the first year**

Conclusion

- ➢ Activation of the solar system is **much more demand-driven / efficient** with a modeled collector temperature.
- ➢ Self-optimization ensures **high model quality** for each collector
- ➢ Very **lucrative upgrade opportunity** for existing plants

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Stahrsolar – Earning more efficiently

The variable reflector

Motivation and target

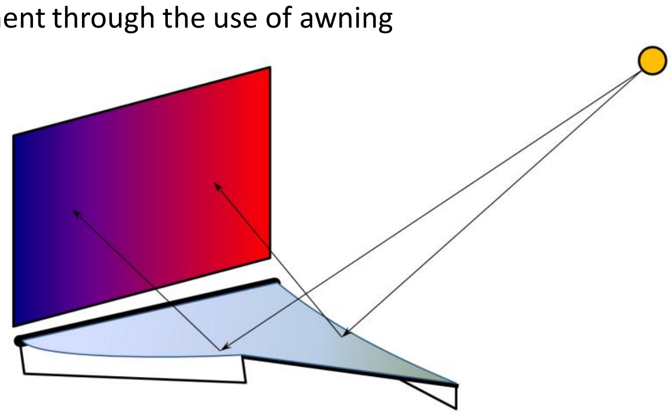
- The available usable area for collector installation is limited
- Solar thermal energy competes with photovoltaics and other applications in terms of space
- Area costs drastically reduce profitability of a collector installation
- Angle of solar radiation to collector surface unfavorable in most of solar operation
- Benefit-cost ratio decreases with system size
- Collector surfaces are partly perceived as disturbing

Target: More usable solar radiation for the collector

Approach

Variable reflector for vertical collektor

- More solar radiation per collector area
- Optimal radiation angle through shape and layer tracking
- Minimal space requirement through the use of awning technology
- Protection and cleaning of the reflector surface by winding up the reflector cloth



Prototype

System:

- 11m² vacuum tubes with water as carrier medium
- 12m² Awning - aluminum coated
- 2 Drive consoles incl. stroke and force measurement

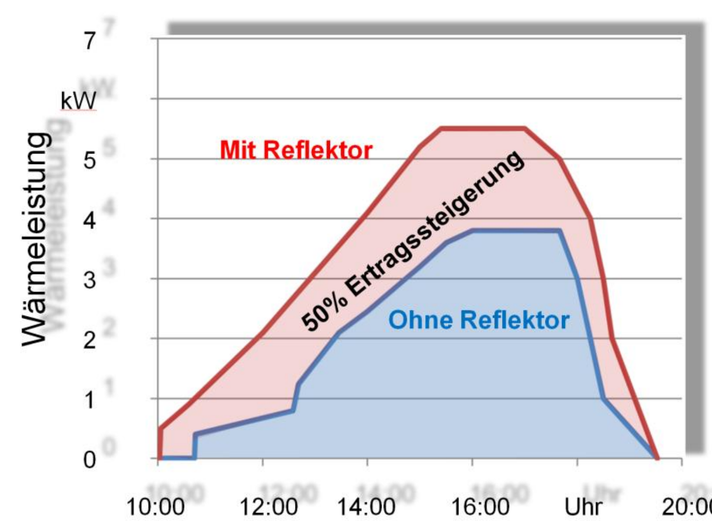
Results

Current testing status :

- Prototype running successfully since 2019 without failures
- Dimensioning of the drive consoles very safe
- Positioning and twisting optimized all year
- Effective protection against excessive wind load and wetness
- Sufficient self-cleaning

Everyday benefit:

- Earlier activation of the solar yield at:
  - Unfavorable position of the sun and
  - Reduced solar radiation (cloud cover, twilight)
  - Increase of solar yield by approx. 50% in annual average
  - Reduced requirement for heat from primary energy source



Economic efficiency

- Awning technology mature and available, necessary changes easily adopted
- Industrial production of reflector cloth currently challenging
- Maintenance-free drive consoles
- Target price: <300€/m²
- BAFA subsidy program applied for

Conclusion

- Significant potential for increasing collector output while maintaining the same installed collector area
- Profitability of small collectors increases
- Attractiveness of solar thermal energy can be increased, especially in urban environments
- Side effect: shading or cooling of living spaces underneath

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Stahrsolar – Earning more efficiently

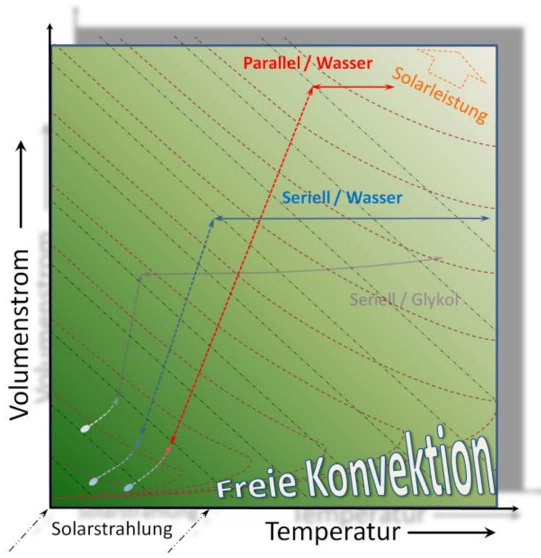
The optimized variable hydraulics

Motivation and Target

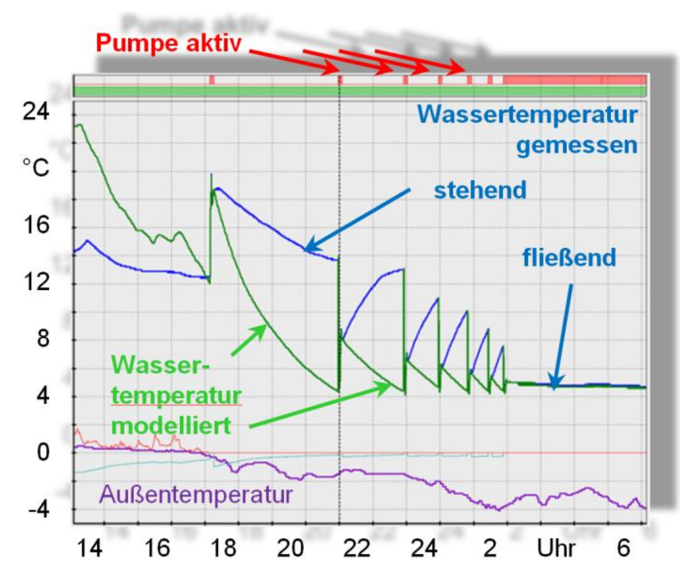
- Costs for auxiliary energy reduce the economic efficiency of a solar system
- Auxiliary energy means mainly el. pumping power, this increases with:
  - Operating time
  - Viscosity of the carrier medium
  - Pressure loss of the entire system
- As the collector temperature increases, its thermal efficiency decreases

Target: minimal hydraulic and thermal losses

Approach

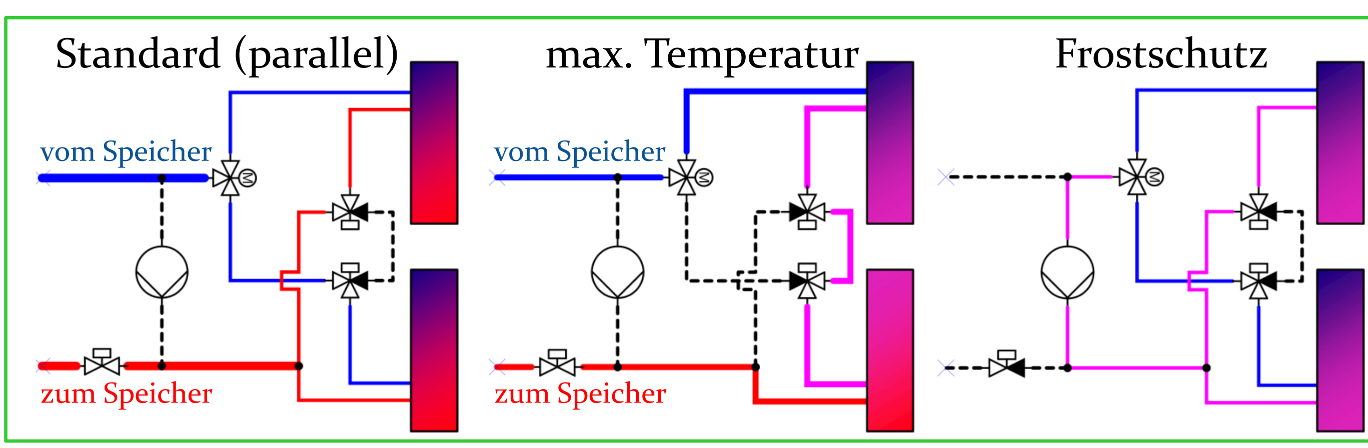


- Water as carrier medium
- Pipe length / superheat adjustable according to demand
- SET superheat precisely controlled
- Pulse-like frost protection
- Closed circulation circuit during frost protection



Prototype

- Independent power supply with 110Wh
- 12m² reflector (see Stahrsolar - The variable reflector)
- 11m² vacuum tubes
- Carrier medium water
- PWM controlled solar pump
- Control unit with switching and adjusting strategies



Results

- ➢ Superheat up to 700W/m² precisely controllable
- ➢ El. pump power <1% of the solar power
- ➢ Proven model (see Stahrsolar - The collector temperature model)
- ➢ Very low frost protection heat demand: 1,8kWh per day at -17°C average outside temperature
- ➢ Repair and maintenance free

Conclusion

- ➢ Maximum yield with minimum electrical and thermal losses
- ➢ Safe and efficient use of water as a carrier medium

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