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# AIR COLLECTORS AND AIR COLLECTOR SYSTEMS

Modeling, Simulation, and Optimization

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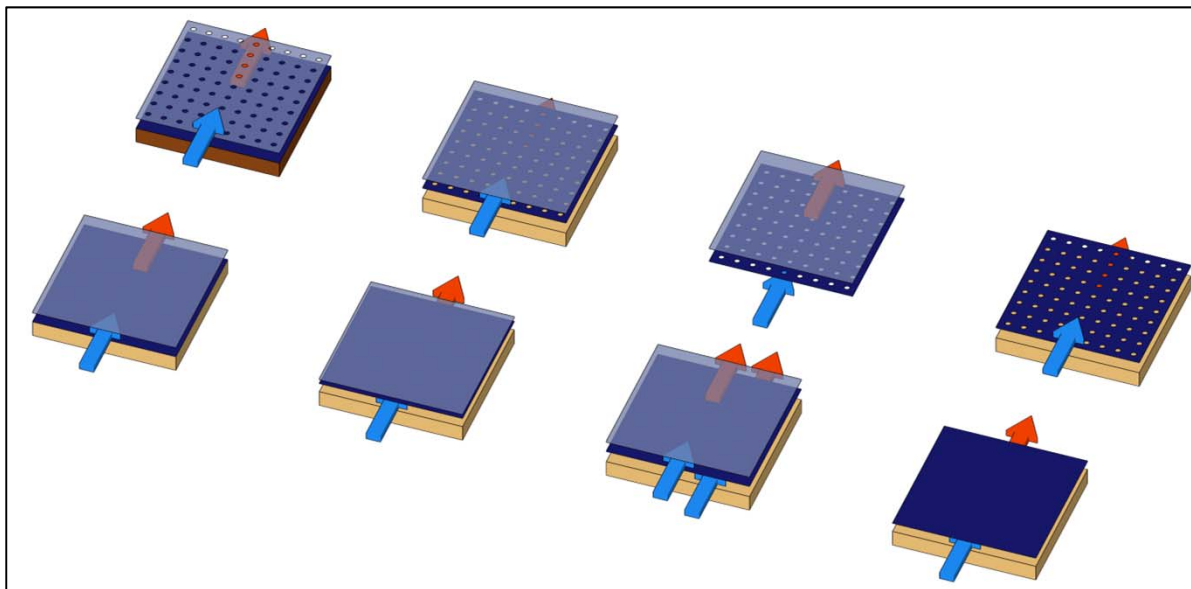
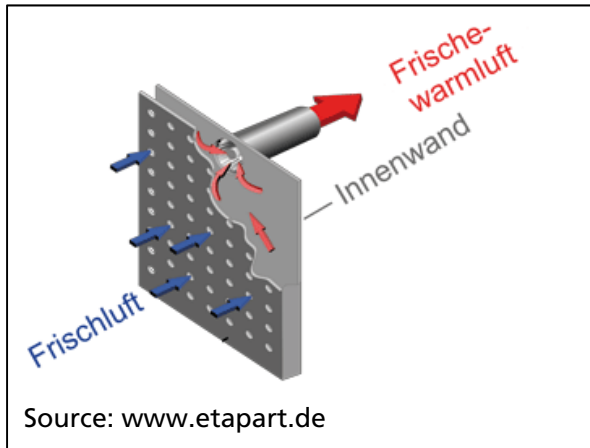
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DAAD – Summer School  
Stuttgart, 06.11.2013

[www.ise.fraunhofer.de](http://www.ise.fraunhofer.de)

# Construction possibilities

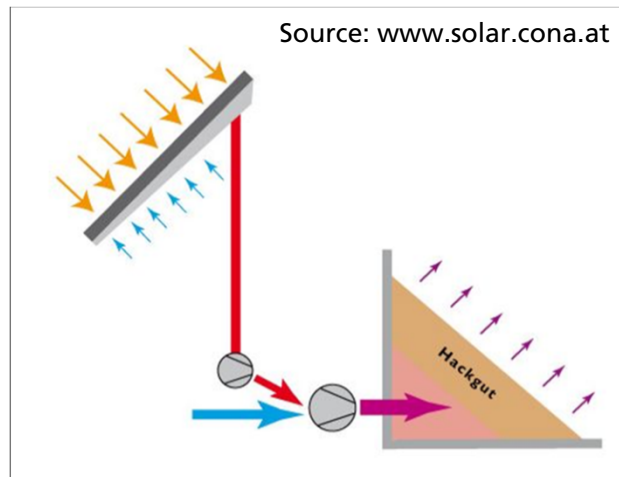


- Uncovered
- Covered
- Vacuum tube
- High construction variety

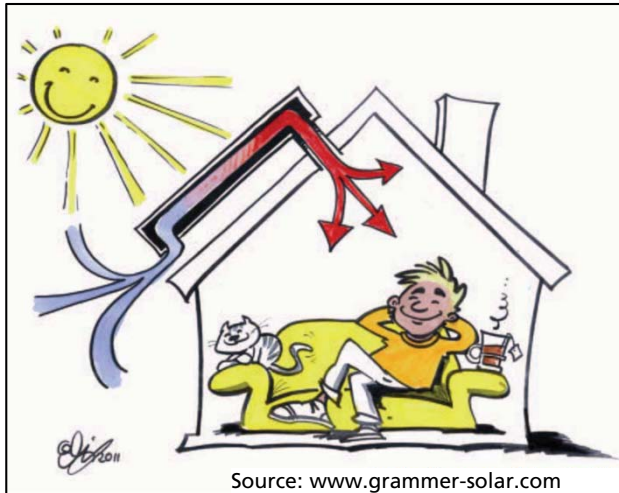
# Application: Process heat (Solar dryers)



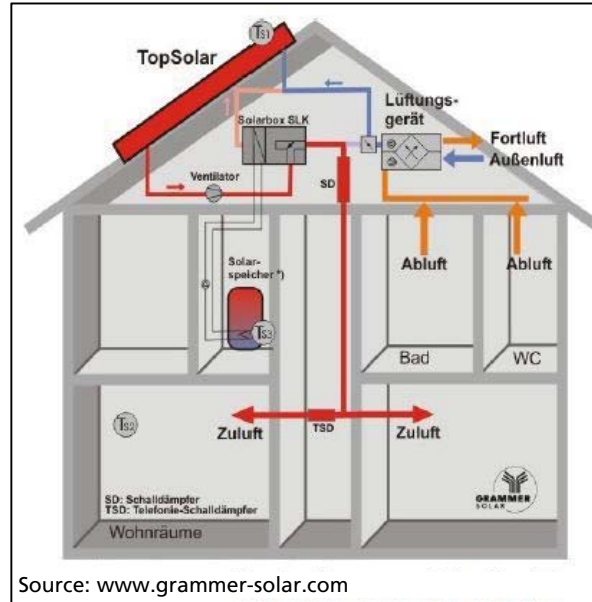
- Agriculture
- Industry



# Application: Space heating



Source: [mosesstructures.com](http://mosesstructures.com)



- Self-sufficient air heating
- Ventilation support and air heating
- Air heating of halls



# Advantages and disadvantages

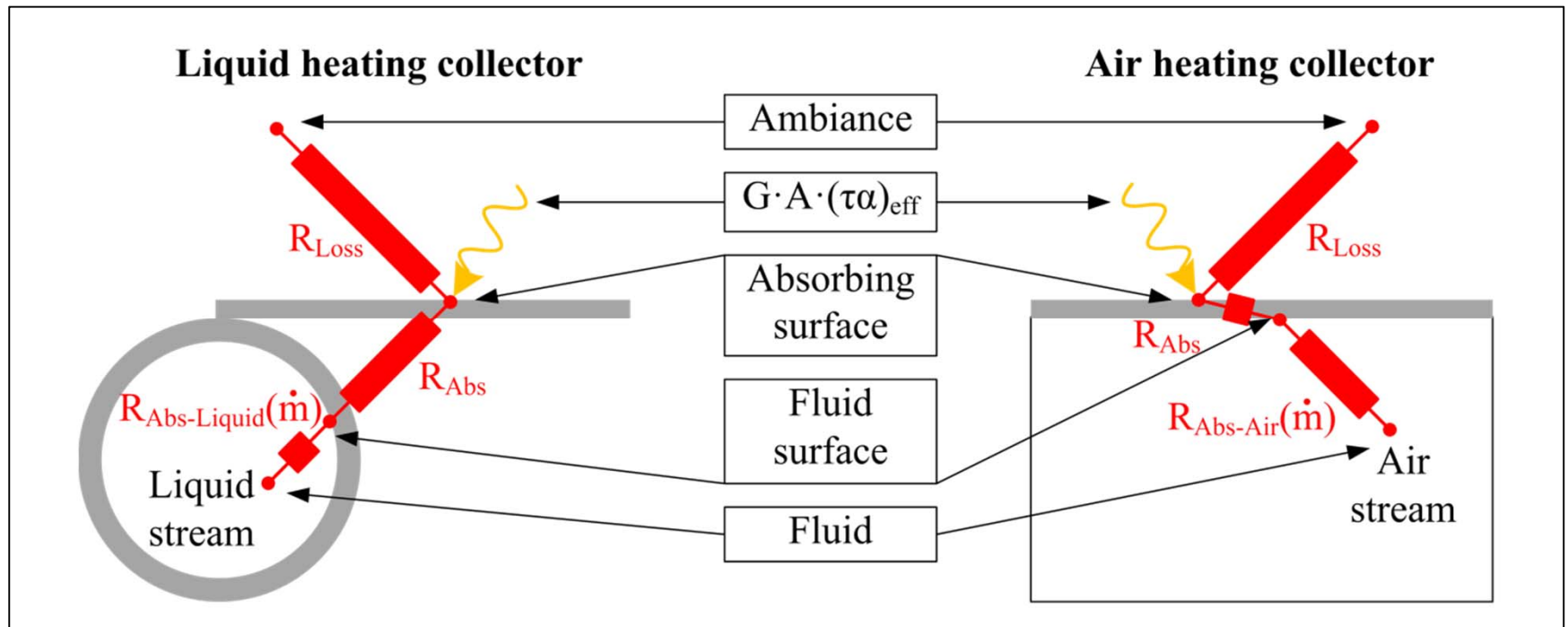
## Disadvantages:

- Low heat capacity of air
- Low heat transfer
- High auxiliary demand of fan
- Heat storage
- Air noise

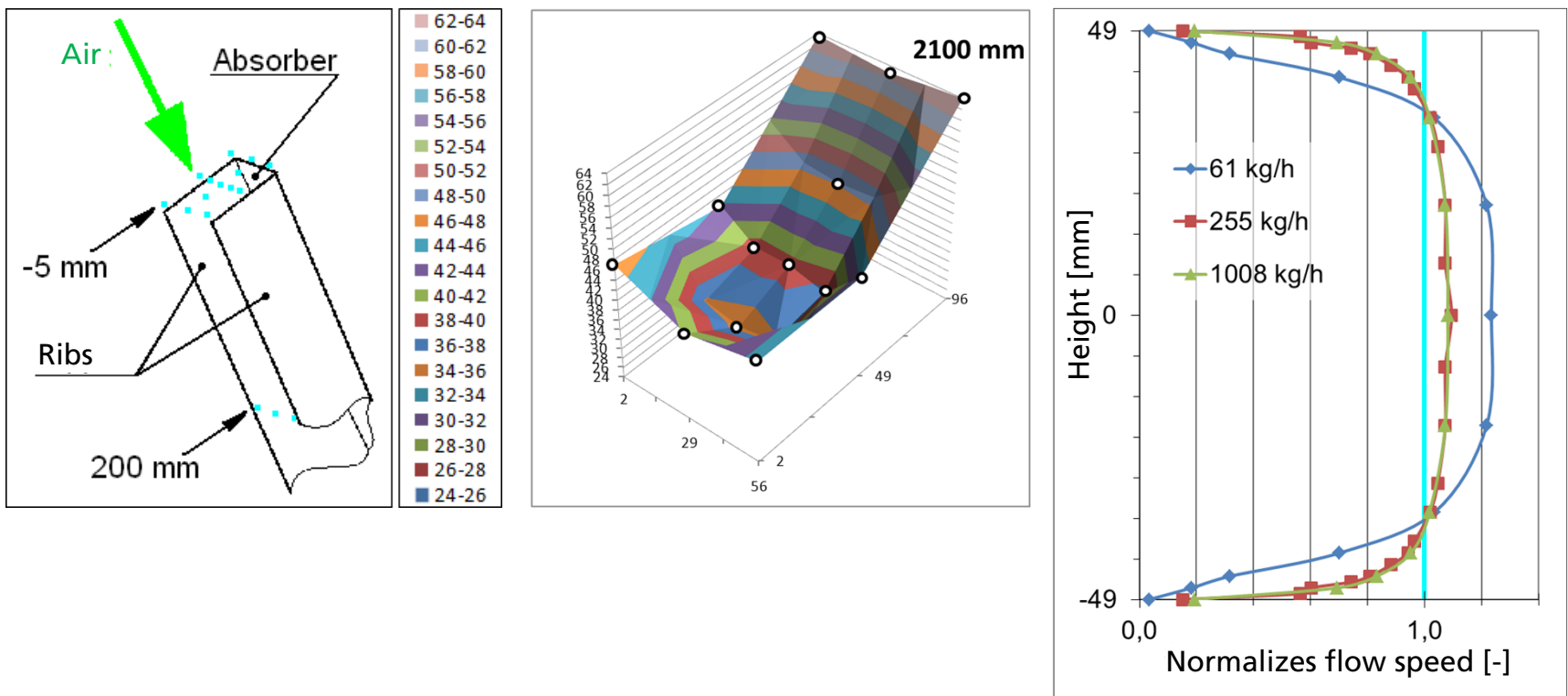
## Advantages:

- No problem with stagnation
- No problem with air leakage
- No problem with freezing
- Direct usability of hot air
- Low maintenance
- Simple and reliable
- Cost-effective

# Main physical difference of liquid and air heating collectors

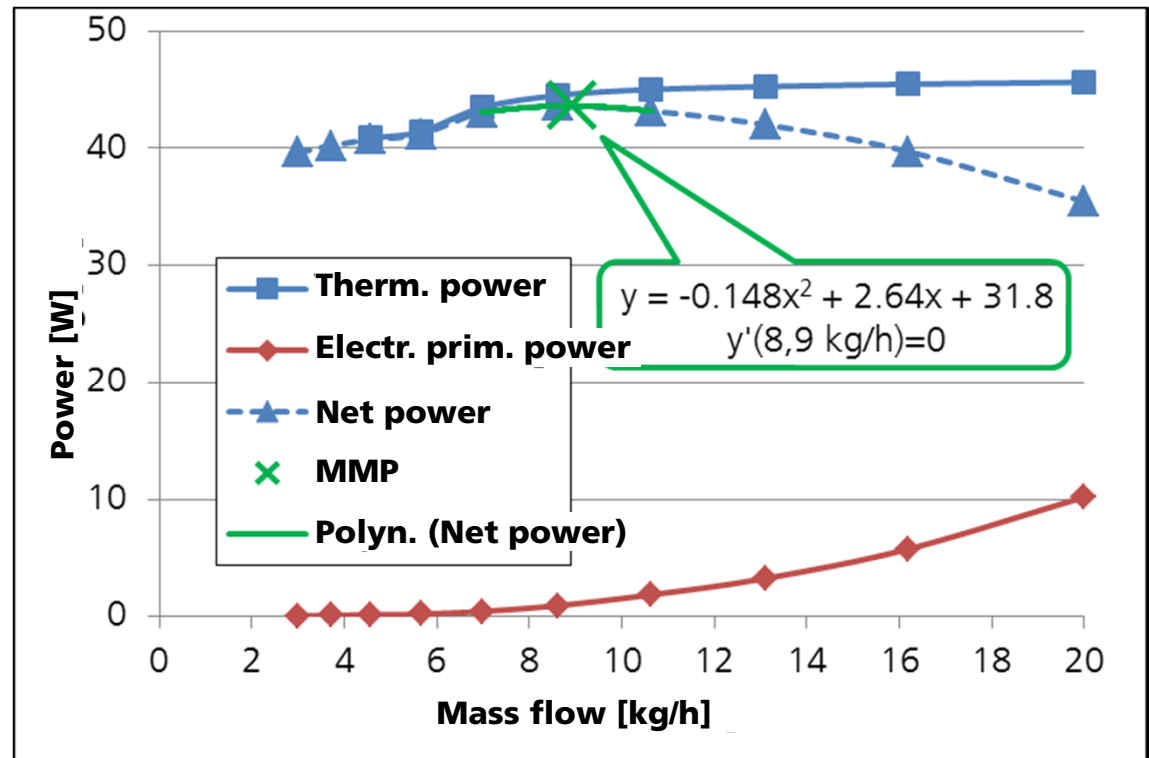


# Measurement of 3D-air-temperatures and flow profiles



# Efficient mass flow

- Pressure drop and resulting auxiliary power is an important issue
- Energetic approach:
  - Mass flow of maximum primary energy saving - **MMP**
- Economic approach:
  - Mass flow of maximum saving of operation costs - **MMC**





# Thermal modeling with mass flow dependency

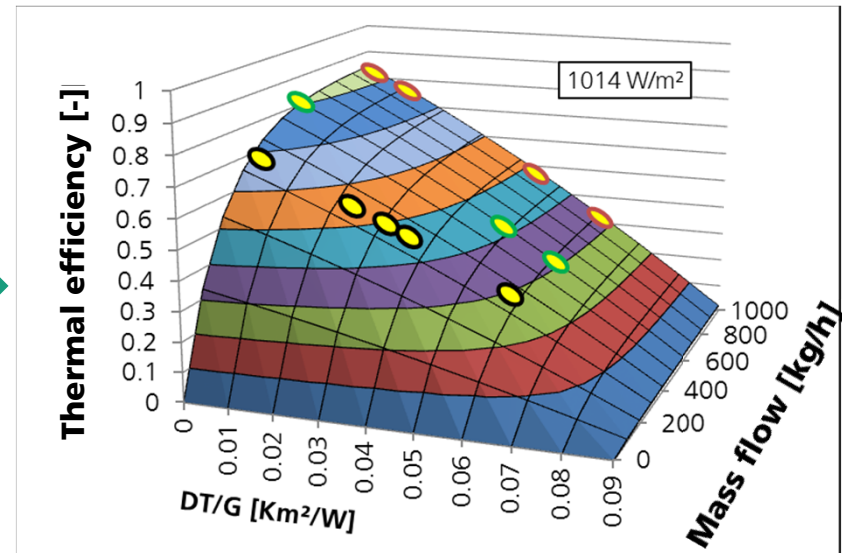
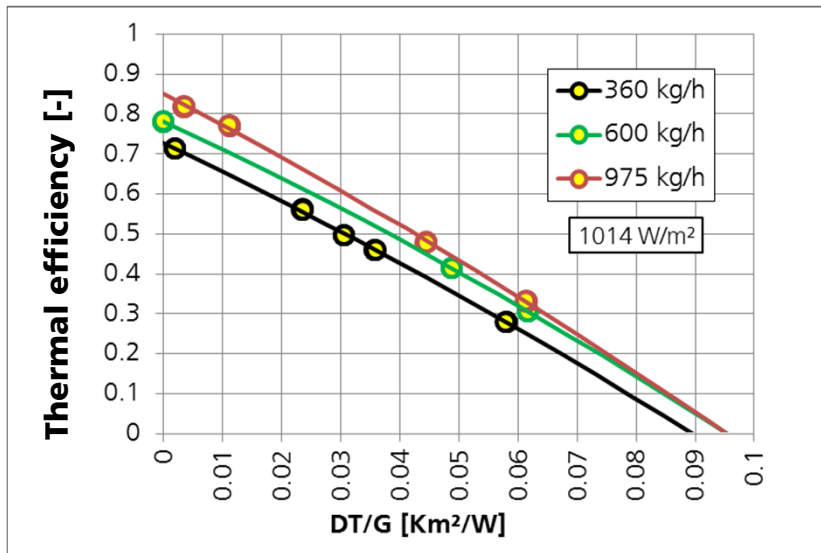
- Efficiency curve

$$\eta(\Delta T/G) = \eta_0 - a_1 \frac{\Delta T}{G} - a_2 \frac{\Delta T^2}{G}$$

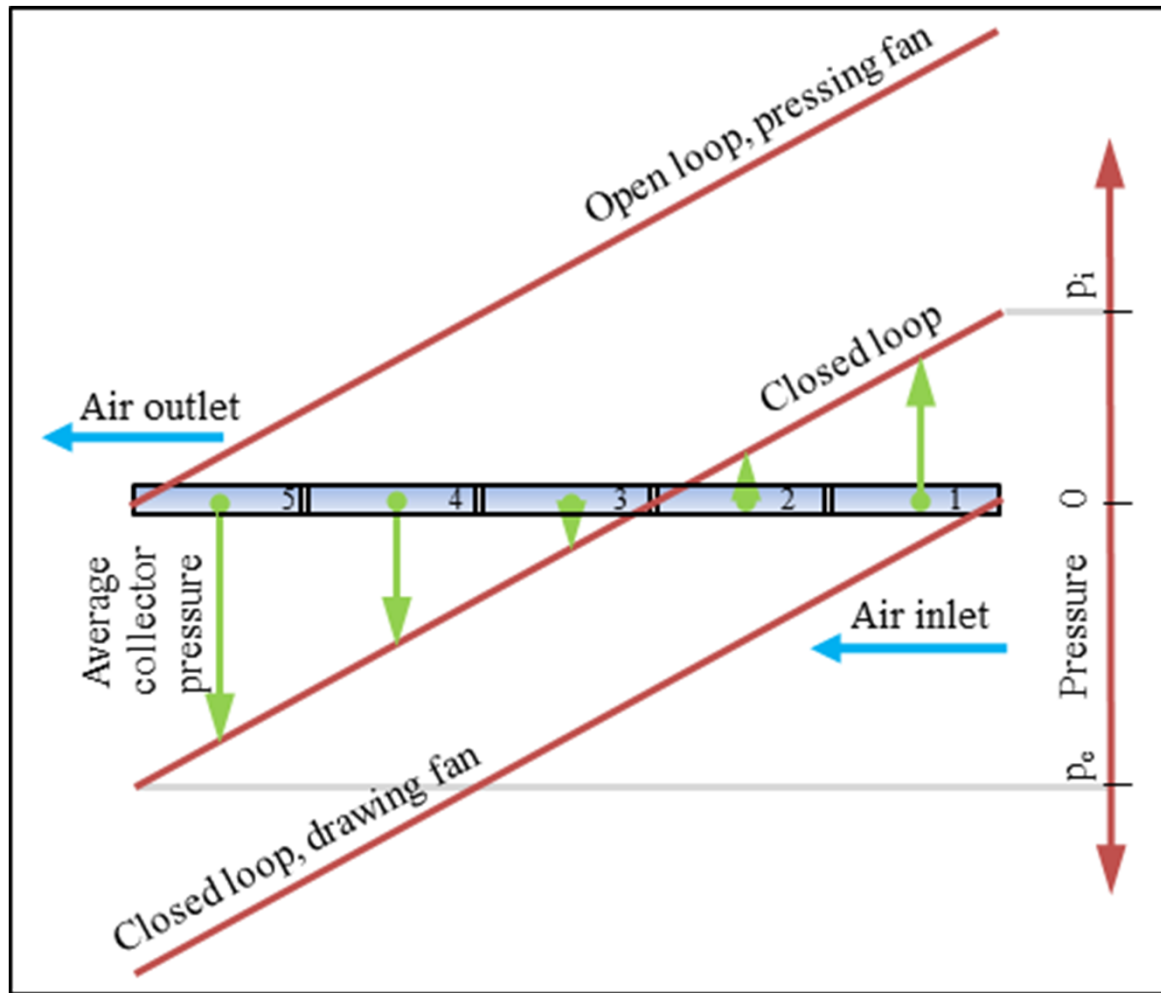
- Efficiency surface

$$\eta(\Delta T/G, \dot{m}) = f(\dot{m}) \cdot \left[ \eta_{0,max} - a_{1,max} \frac{\Delta T}{G} - a_{2,max} \frac{\Delta T^2}{G} \right]$$

$$f(\dot{m}) = 1 - \exp(-d_3 \cdot \dot{m})$$



# Modeling of leakage



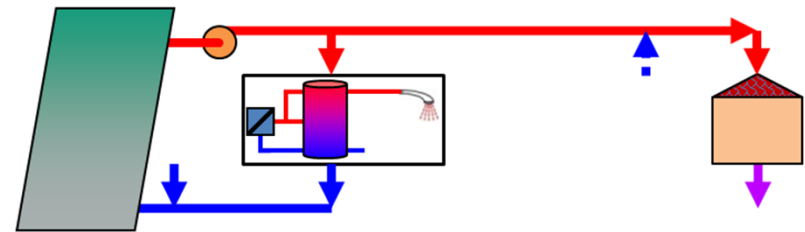
- 3 system cases with 6 models each

# System simulation with software TRNSYS

## Solar ventilation support



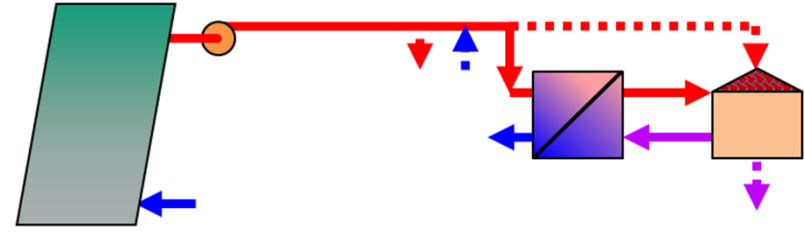
## Solar ventilation support with domestic hot water heating



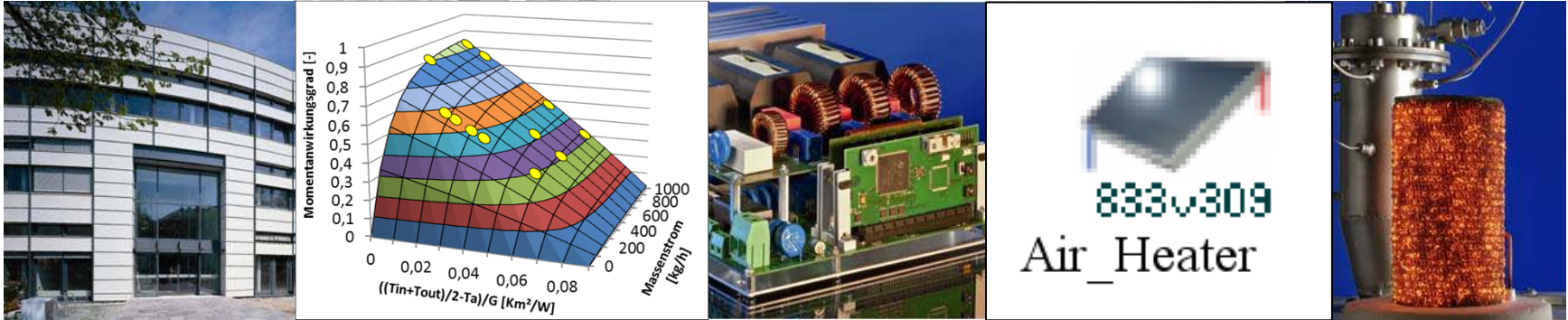
## Solar space heating



## Solar ventilation support with heat recovery



# Thank-you for your attention!



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