TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

# A new control strategy for the exploitation of solar energy

Matthias Gladt, Sebastian Zilles and Thomas Bednar

$$Q = c \cdot m \cdot \Delta T$$

Accumulated thermal energy

Thermal mass

Temperature difference

$$Q = c \cdot m \cdot \Delta T$$

Accumulated thermal energy

**Thermal mass**

- Construction elements
- Buffer tanks

**Temperature difference (winter)**

- ~0 K for construction elements
- <70 K for buffer tanks

$$Q = c \cdot m \cdot \Delta T$$

Accumulated energy buffer tank:

Small:
1 $m^3$ · 50 K ≈ 58 kWh

Big:
10 $m^3$ · 50 K ≈ 581 kWh

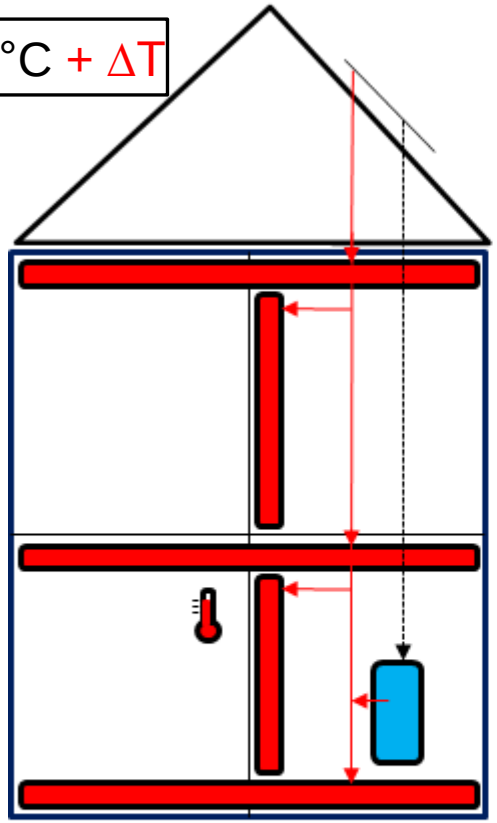
Accumulated thermal energy

| Thermal mass | Temperature difference (winter) |
|---|---|
| • Construction elements | • <5 K for construction elements |
| • Bigger buffer tanks | • <70 K for buffer tanks |

Bigger buffer tanks vs. overheating the building:
Can an increase of ΔT be as effective as an increase of c · m?

**Direct activation, overheat**

$T_{Air}$ > 20 °C + ΔT

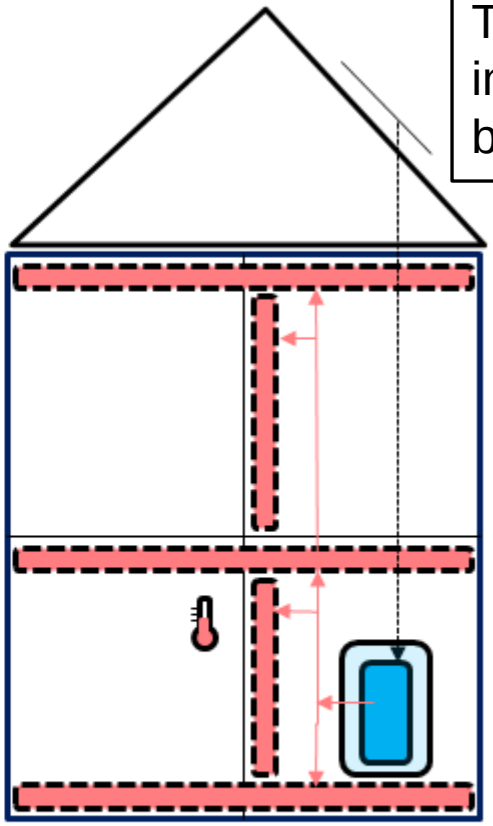


**Amount of overheat gap is varied between 0 and 4 K (72 simulations)**

**Size of buffer tank is varied between 1 and 15 m3 (40 simulations)**

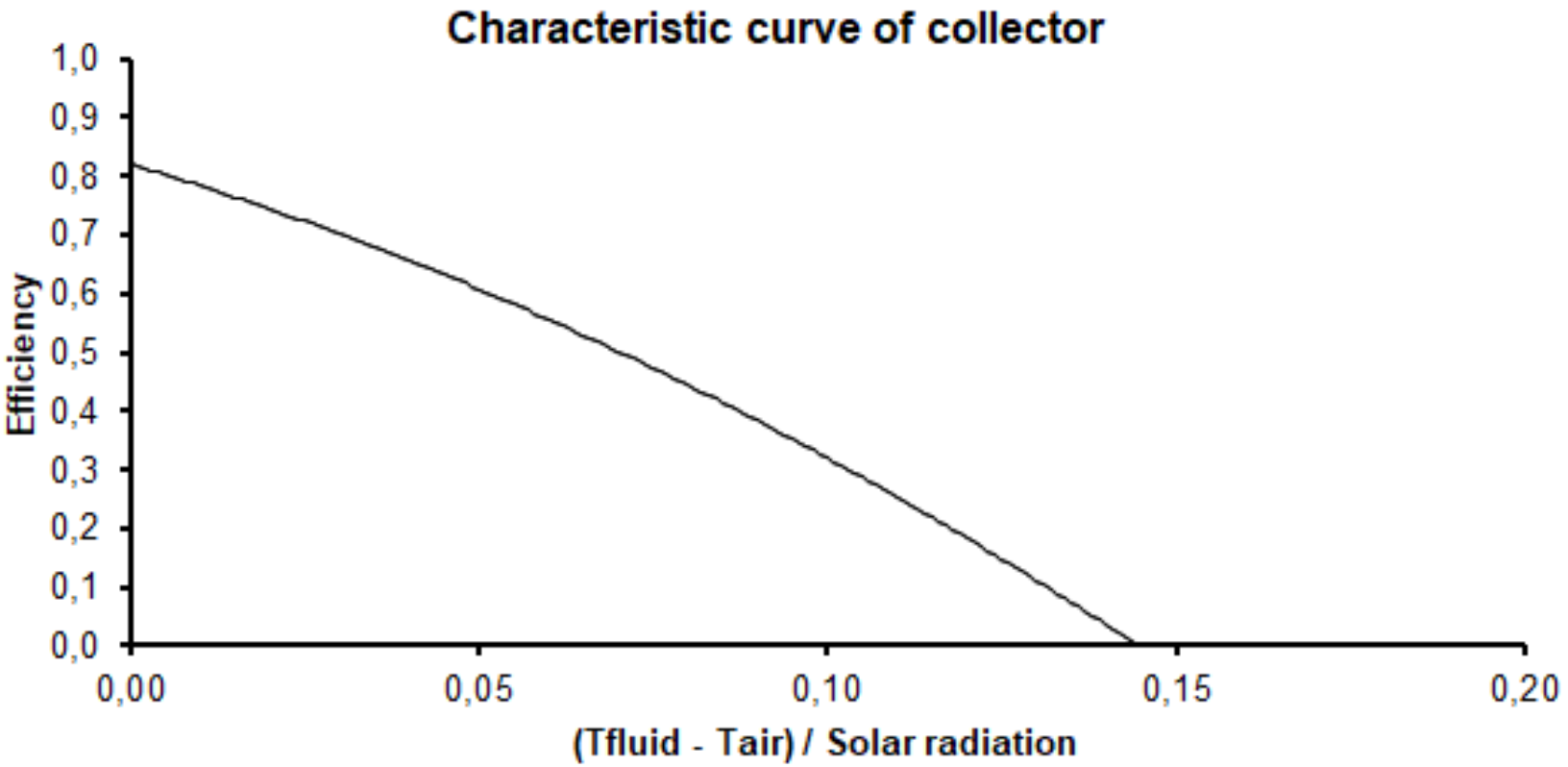
**No direct activation, no overheat**

$T_{Air}$ > 20 °C, increasing buffer tanks



**Buffer tank**
**Activated overheated**
**Activated not overheated**

- Living space: 250 m²
- 25 m² solar collector
- Need for hot water ignored
- 3 activated construction elements (d=0.2-0.25, concrete)
- Average Austrian climate




Solar collectors work better with lower fluid temperature levels

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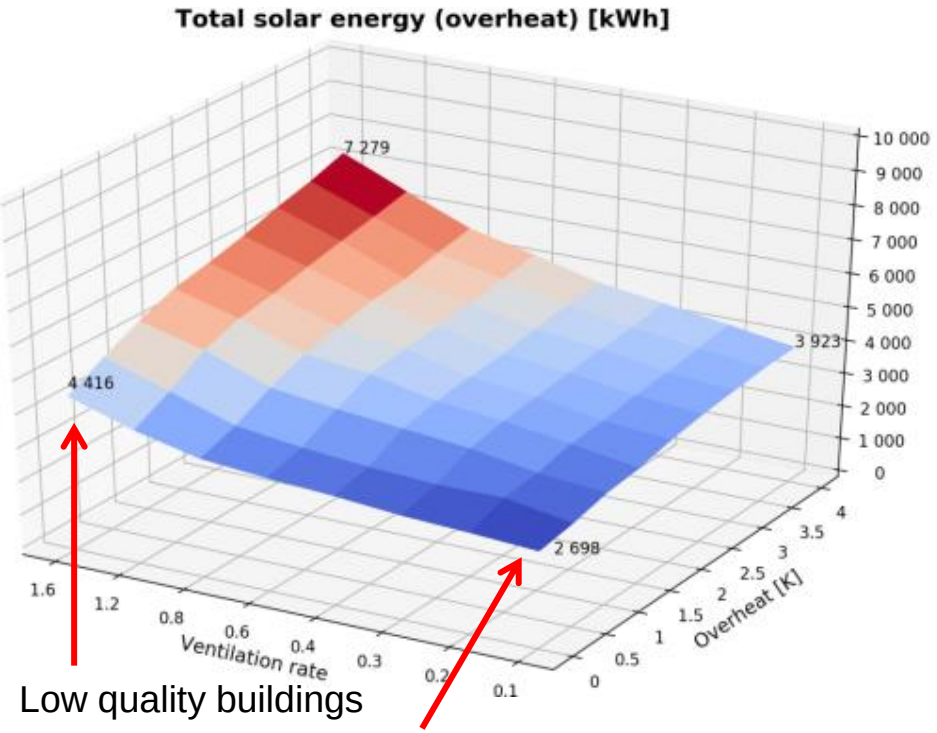
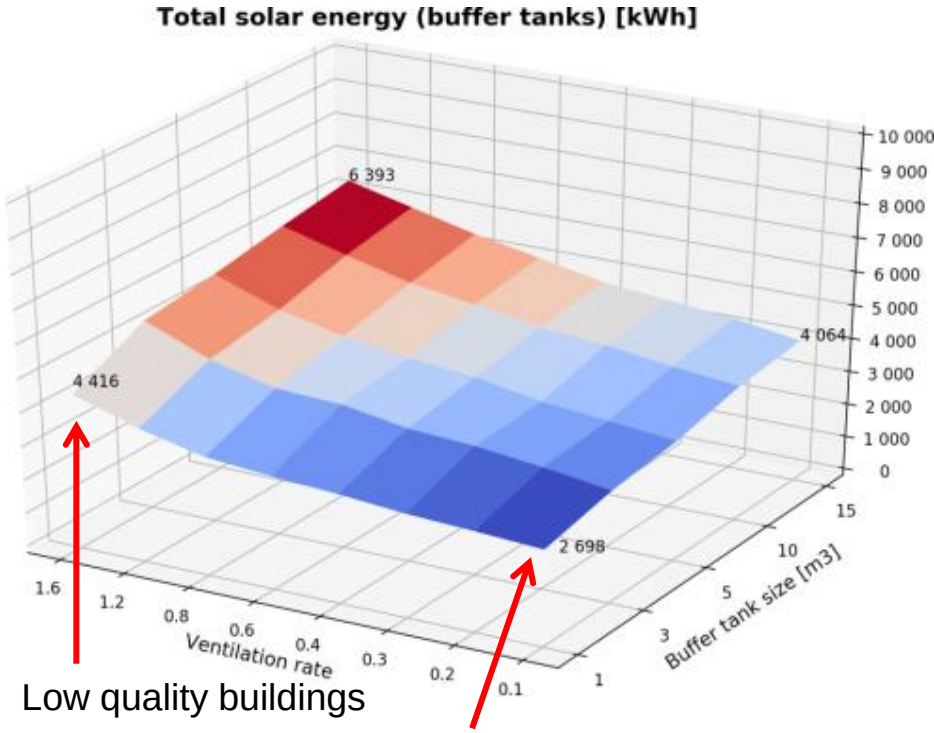



Low quality buildings

High quality buildings

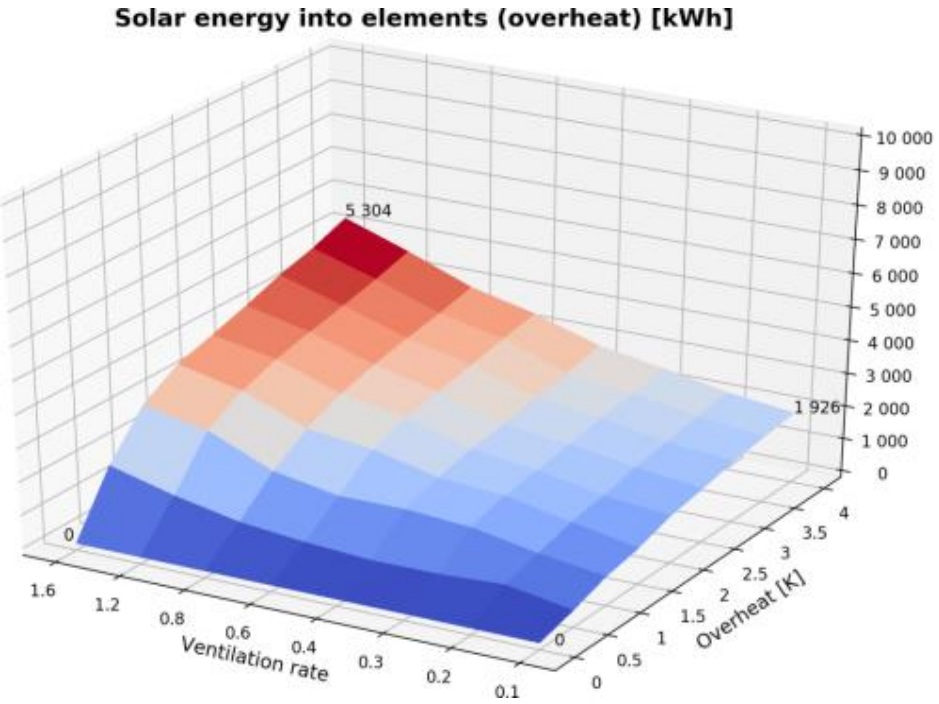


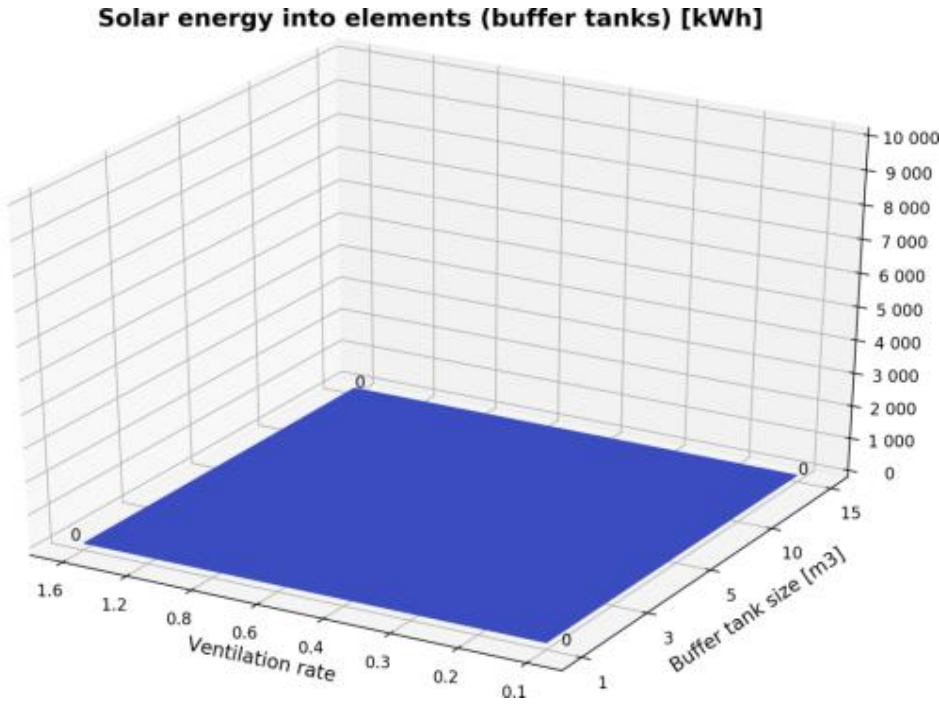

Low quality buildings

High quality buildings

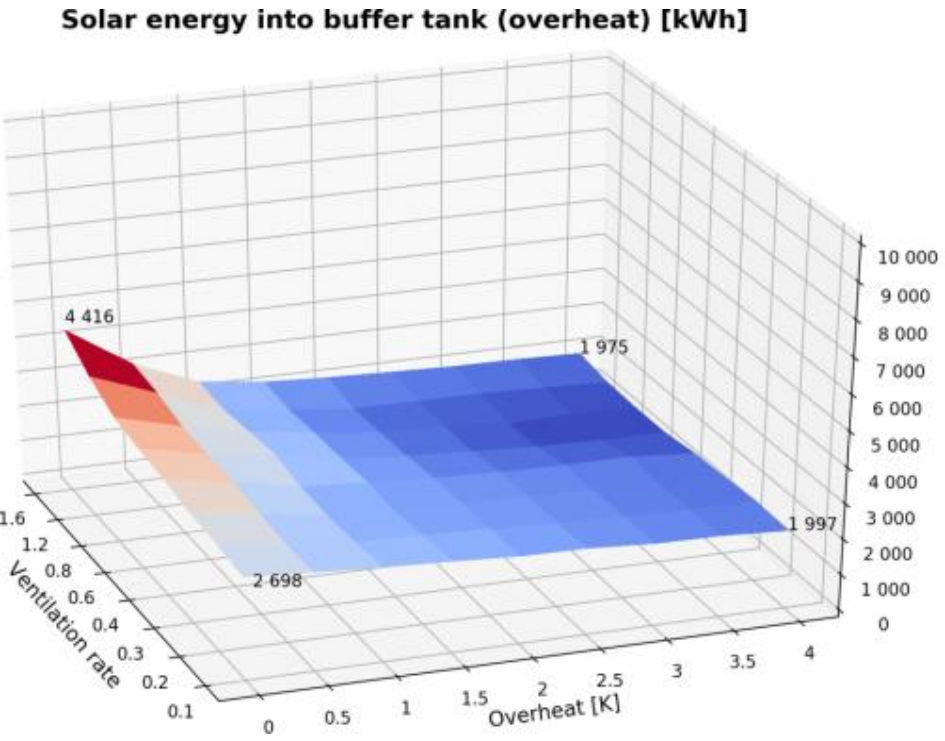
- Ventilation rate varied between 0.1 and 1.6
- Insulation reduced by 0 to 7 cm
- Amount **increases** with raising overheat / buffer tanks

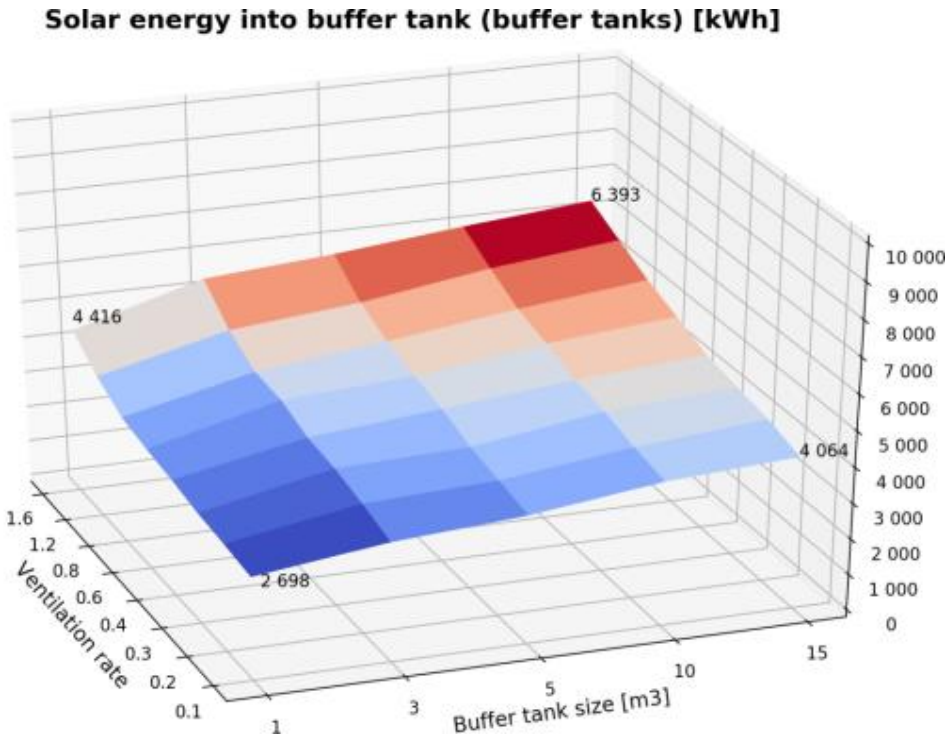
- $\Delta T$ is varied between 0 and 4 K
- Buffer tank size is varied between 1 and 15 $m^3$



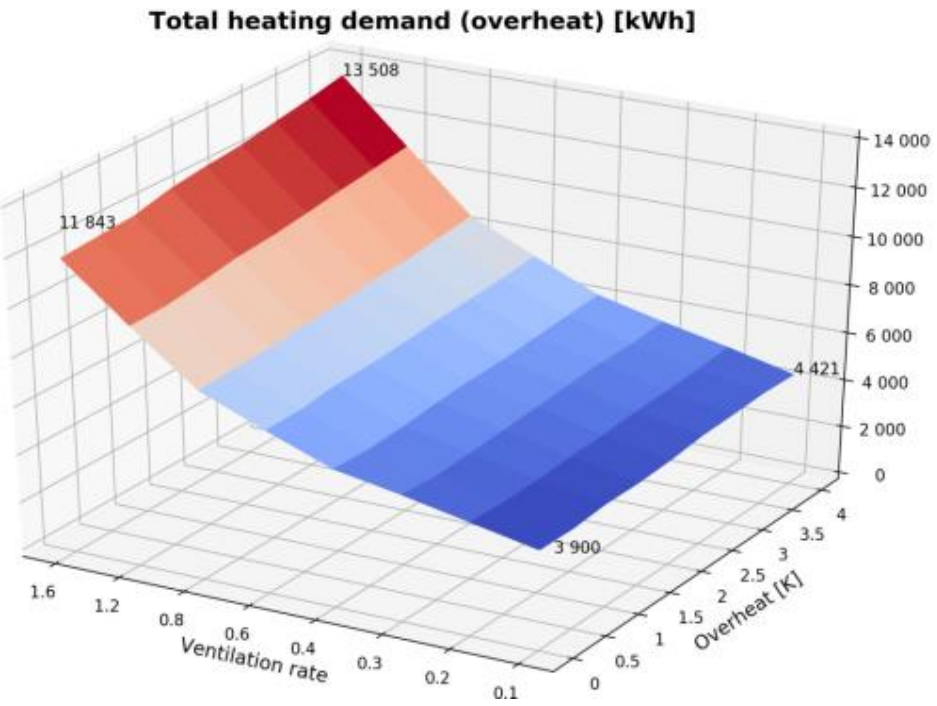



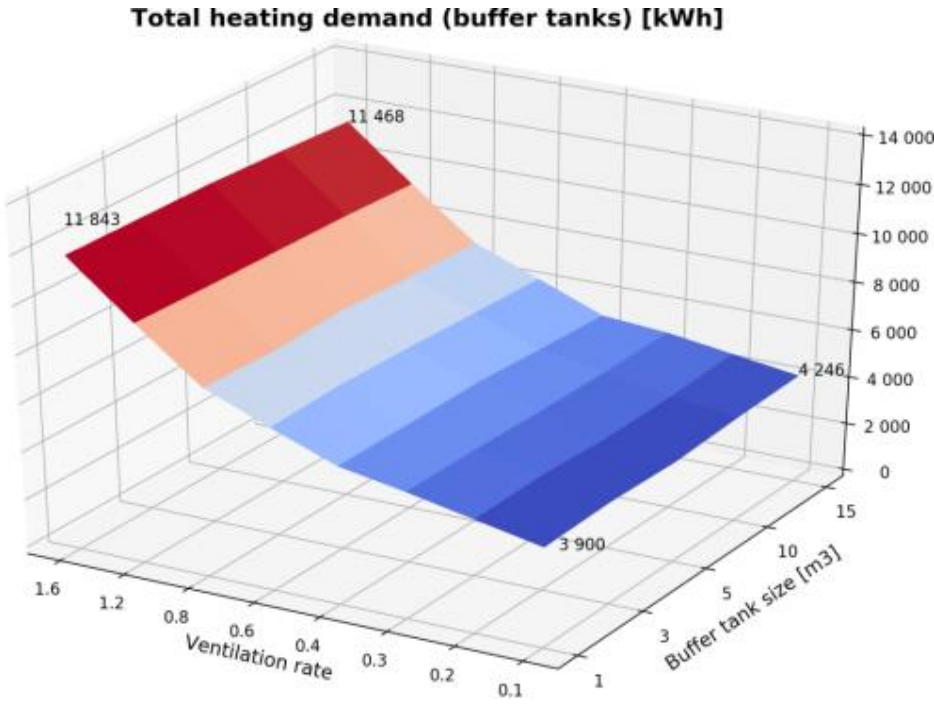

1/2:
No solar energy directly into building with big buffer tanks



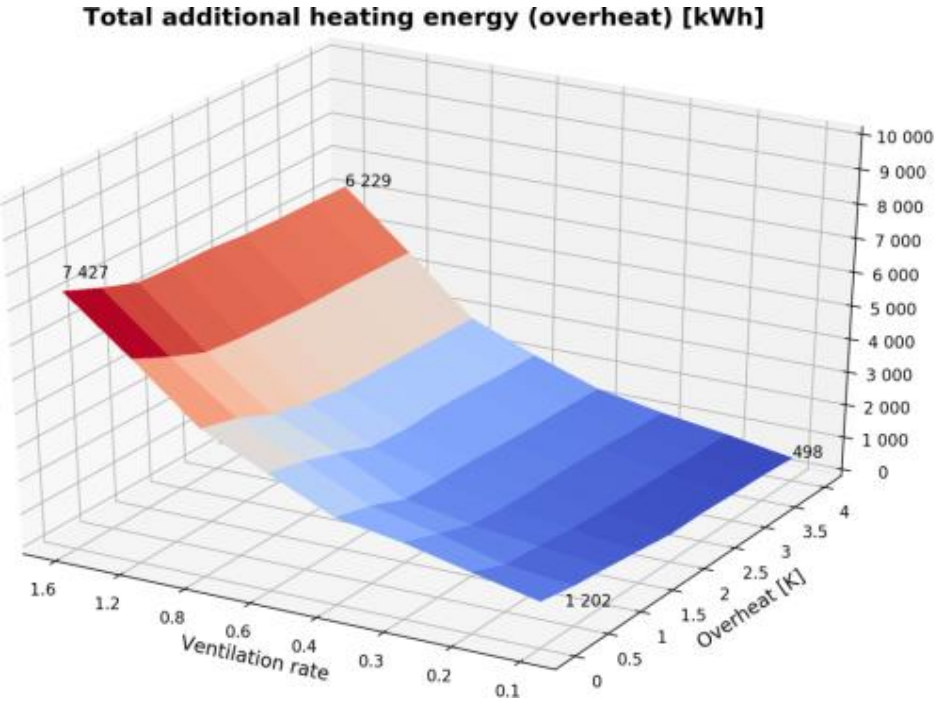



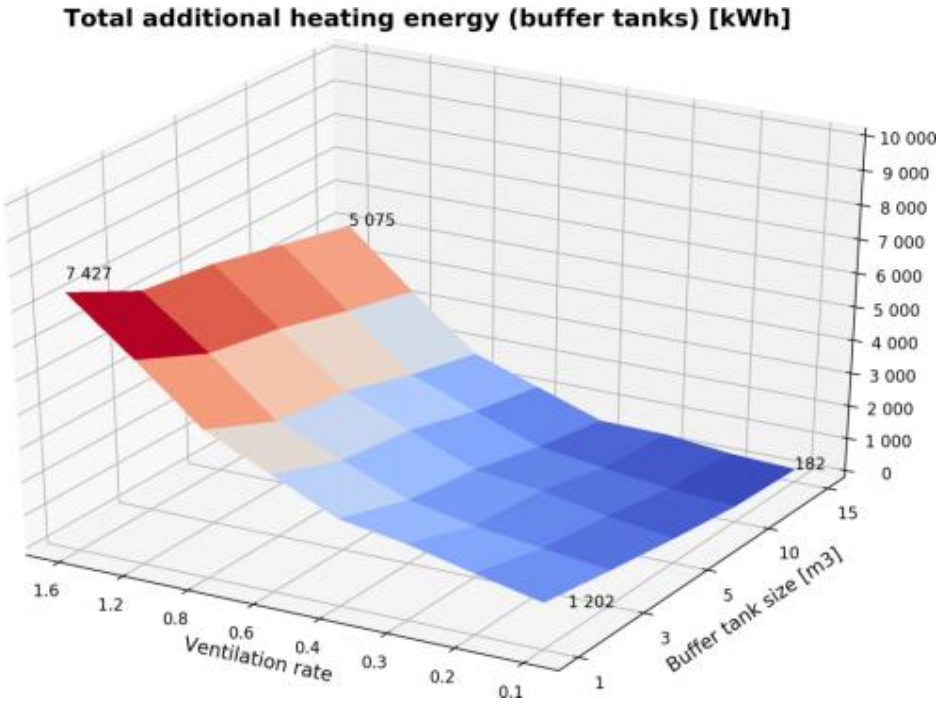

2/2:
Opposite characteristic for the two sets of models

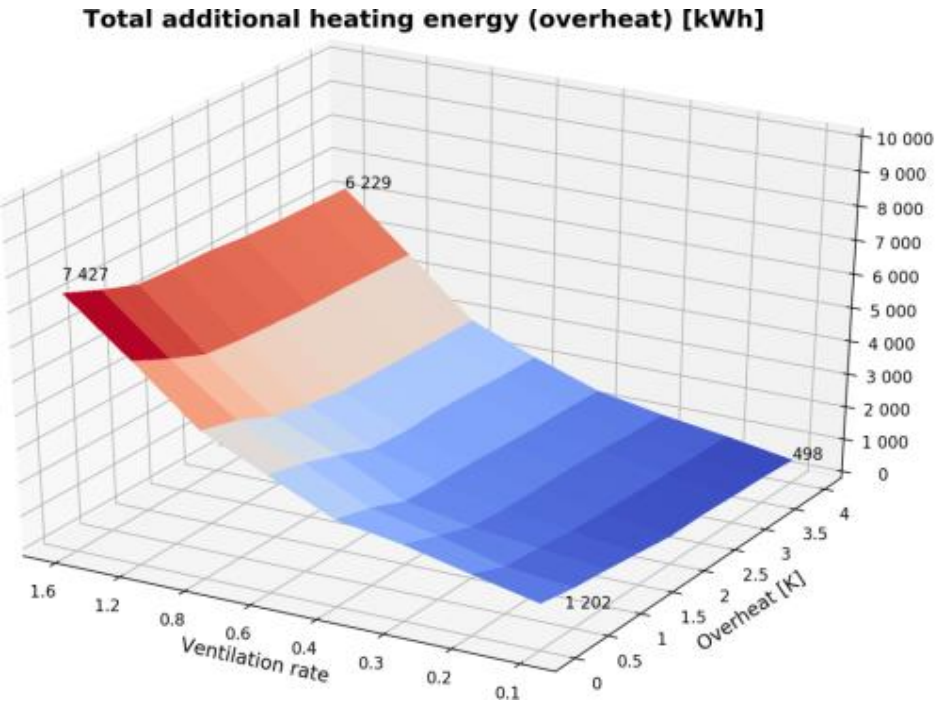


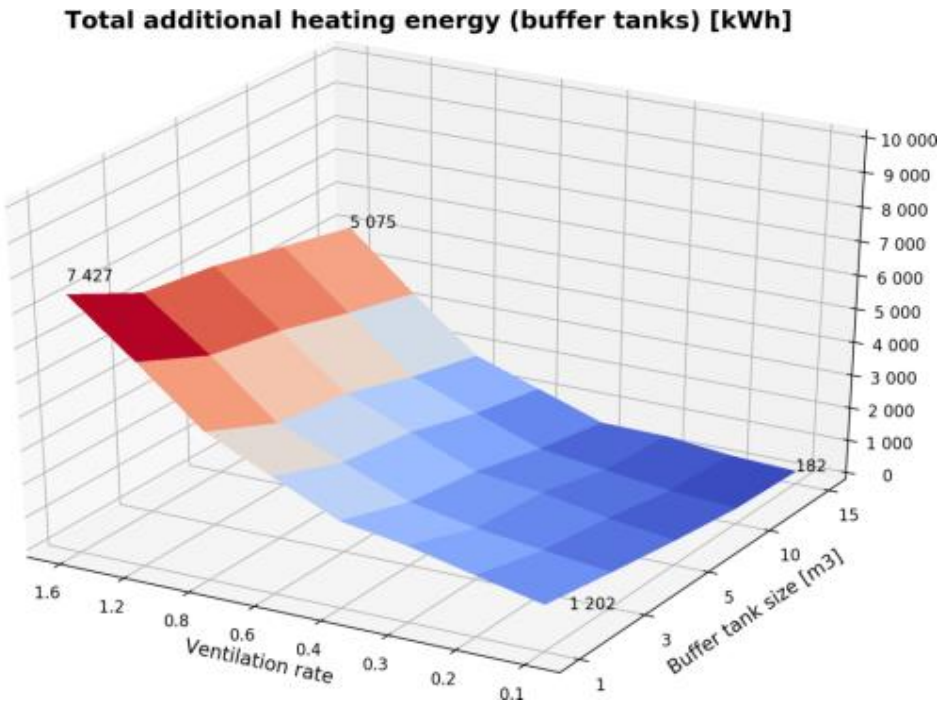




- Total heating demand **increases** with when overheat is increased


Total additional heating energy (overheat) [kWh]
7 427
6 229
1 202
498
10 000
9 000
8 000
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
1.6
1.2
0.8
0.6
0.4
0.3
0.2
0.1
Ventilation rate
0
0.5
1
1.5
2
2.5
3
3.5
4
Overheat [K]


Total additional heating energy (buffer tanks) [kWh]
7 427
5 075
1 202
182
10 000
9 000
8 000
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
1.6
1.2
0.8
0.6
0.4
0.3
0.2
0.1
Ventilation rate
1
3
5
10
15
Buffer tank size [m3]




- Additional heating energy **decreases** when overheat is increased
- Similar characteristics

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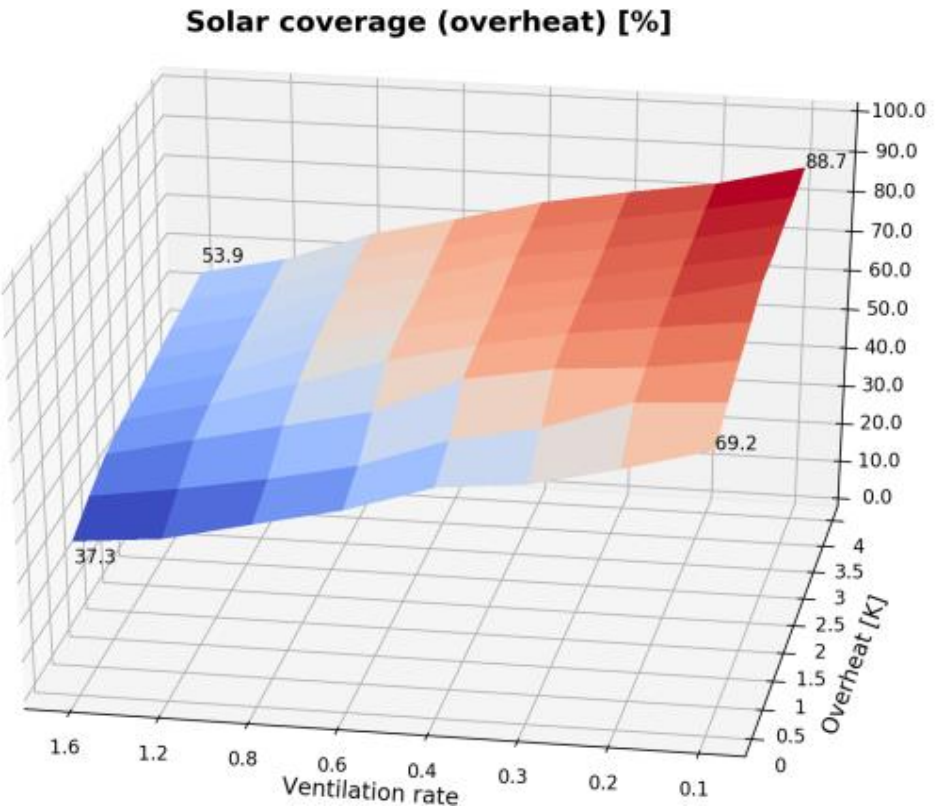


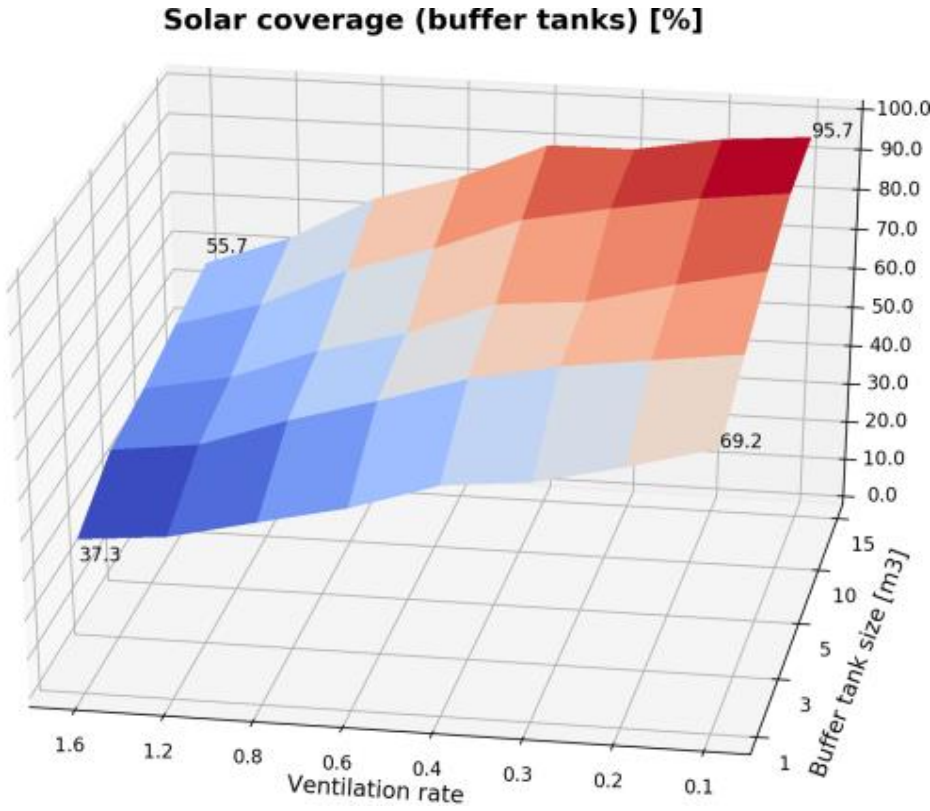

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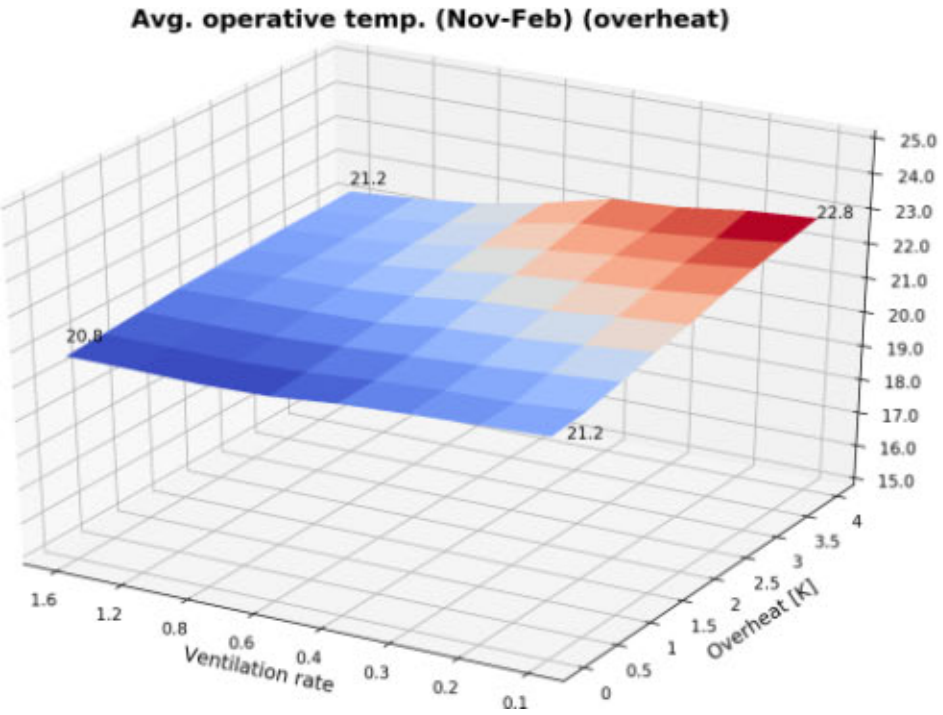


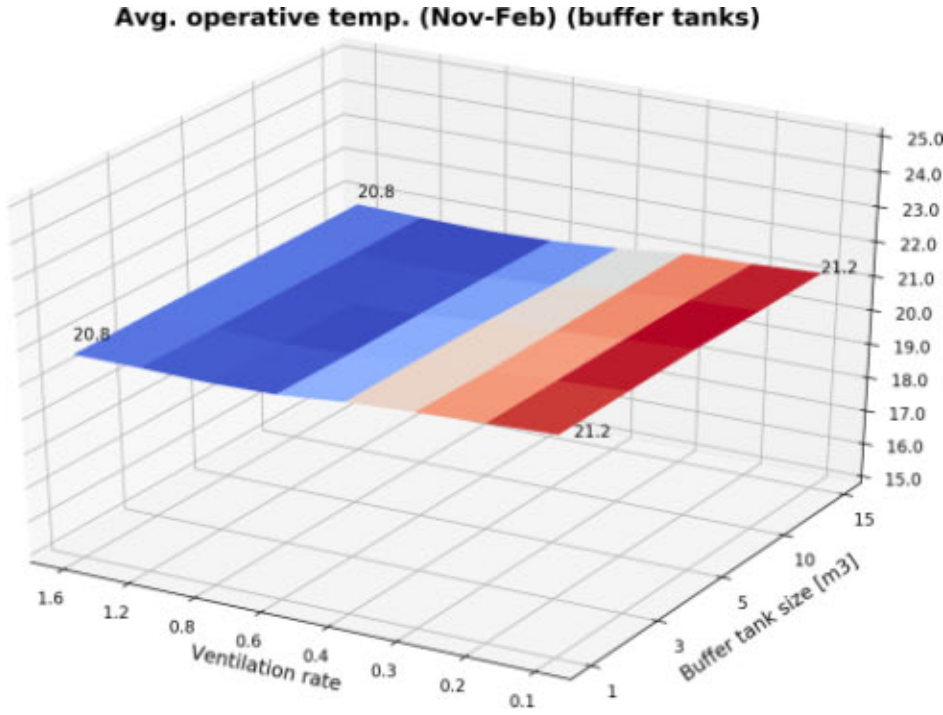

# Conclusion

+ Overheat strategy produces similar results as bigger buffer tanks
+ Room for buffer tank saved
+ Installation costs saved
+ Strategy easy to implement

- Additional installation effort
- Strategy limited by maximum tolerable temperature gap whereas buffer tanks are limited by available space only
- Residents need to accept higher operational temperatures without opening windows

# Questions?

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