# Experiences with Micro-Cogeneration in Residential Buildings in Germany

Workshop

"Building Integration of Micro-Generation Technologies"

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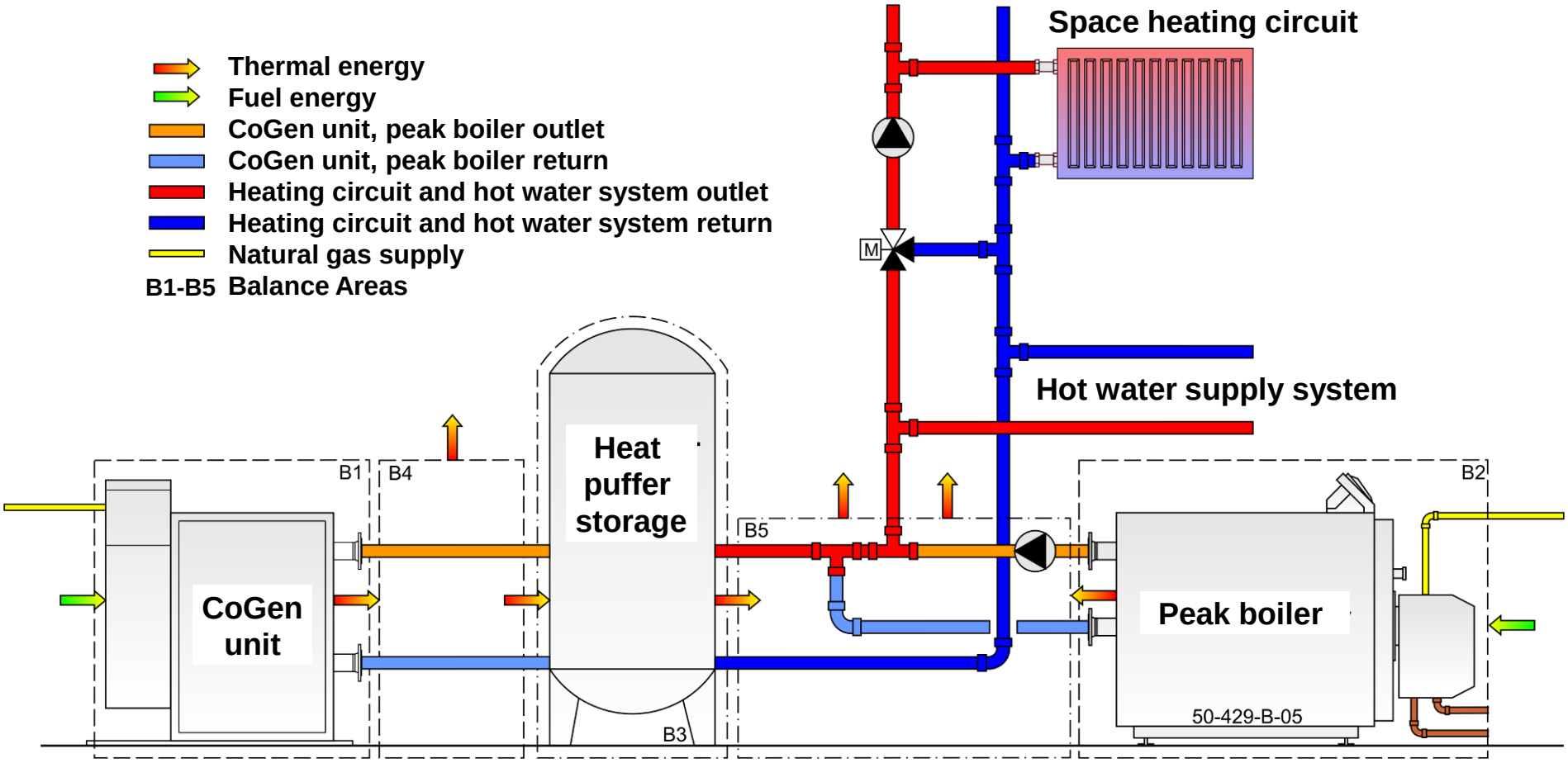
# Outline



- Studied Systems
- Lab tests at TUM
  - System Integration
  - Results
  - Energy, $CO_2$ savings
- Field tests in southern Bavaria
  - System Integration
  - Results

# Hydraulic Scheme
# - Example Senertec Dachs





# Installed Systems



L

Senertec
Dachs

5,5 $kWh_{el}$,
14,0 $kWh_{th}$


L

Solo Stirling
Mod. 161

7,5 $kWh_{el}$,
22,0 $kWh_{th}$


L F

Vaillant
ecoPower

4,7 $kWh_{el}$,
12,5 $kWh_{th}$

F

Remeha
eVita

1,0 $kWh_{el}$,
5,0 $kWh_{th}$
+ aux. burner

~~F~~

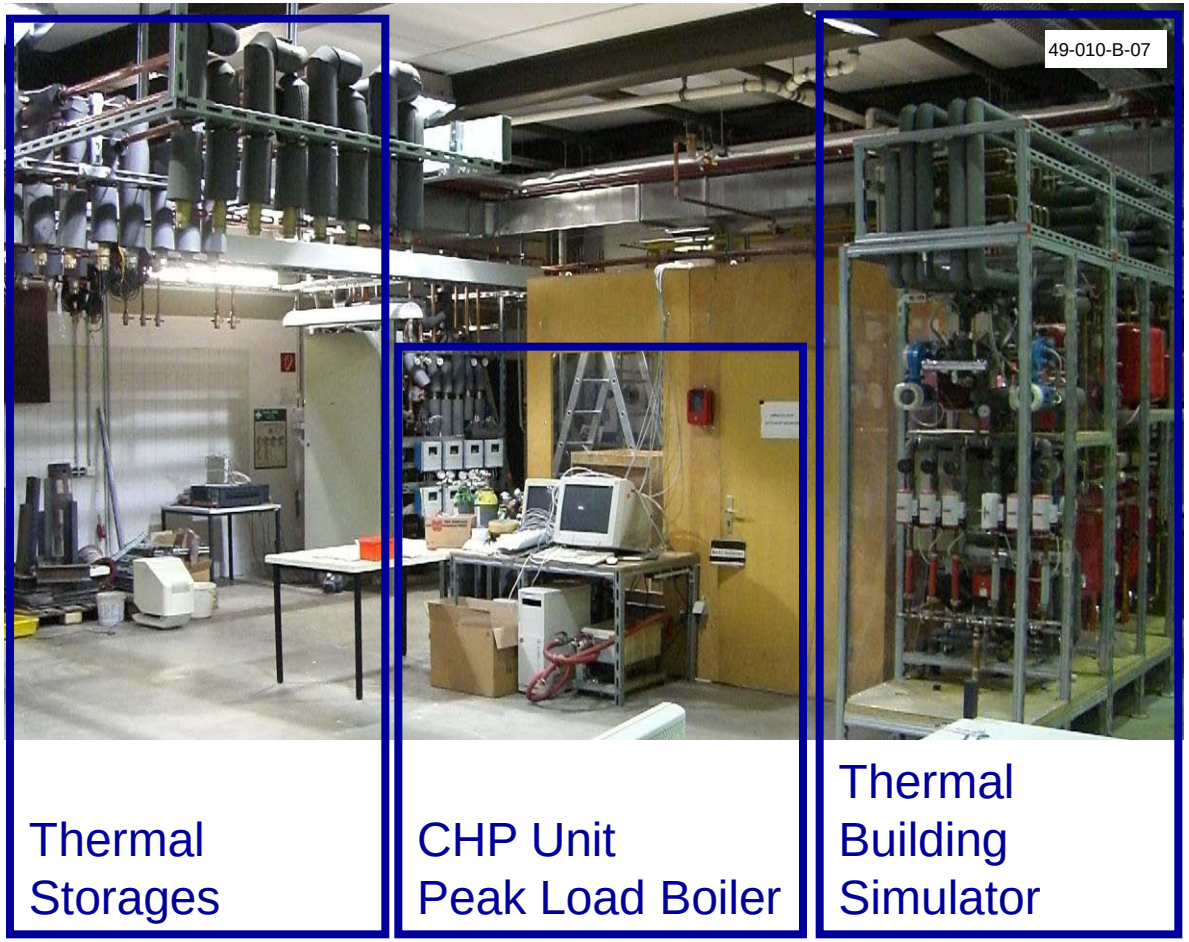
OTAG
Lion PB

2,2 $kWh_{el}$,
18,0 $kWh_{th}$

# Test Bench at TUM

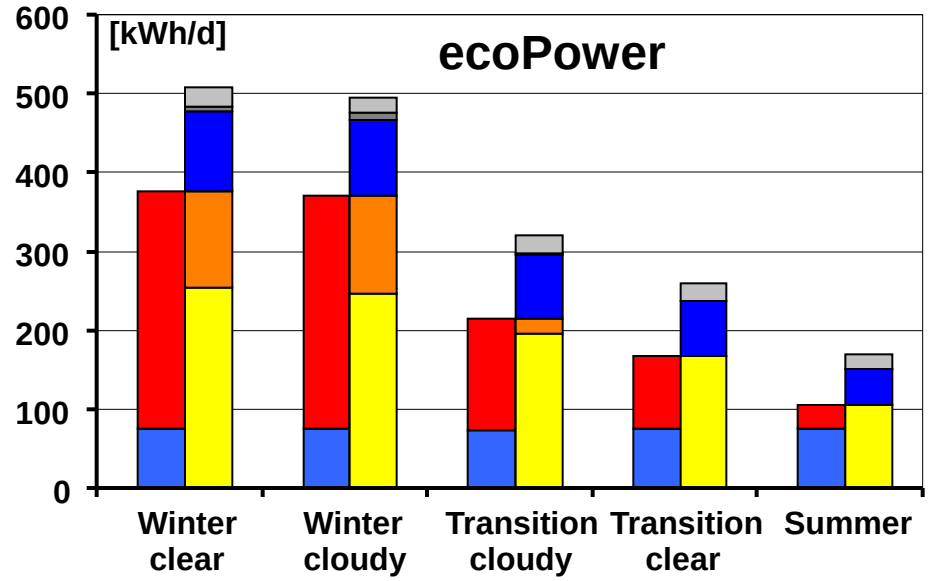


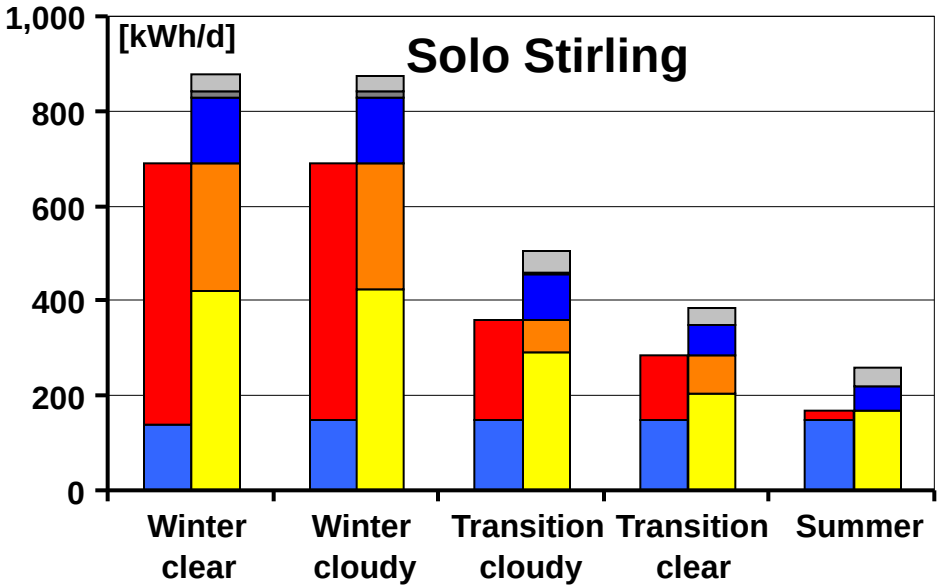
- Close to reality experiments
- Reproducible conditions
- Acquisition of all relevant parameters
- Application of type-days
  - summer
  - transition
  - winter

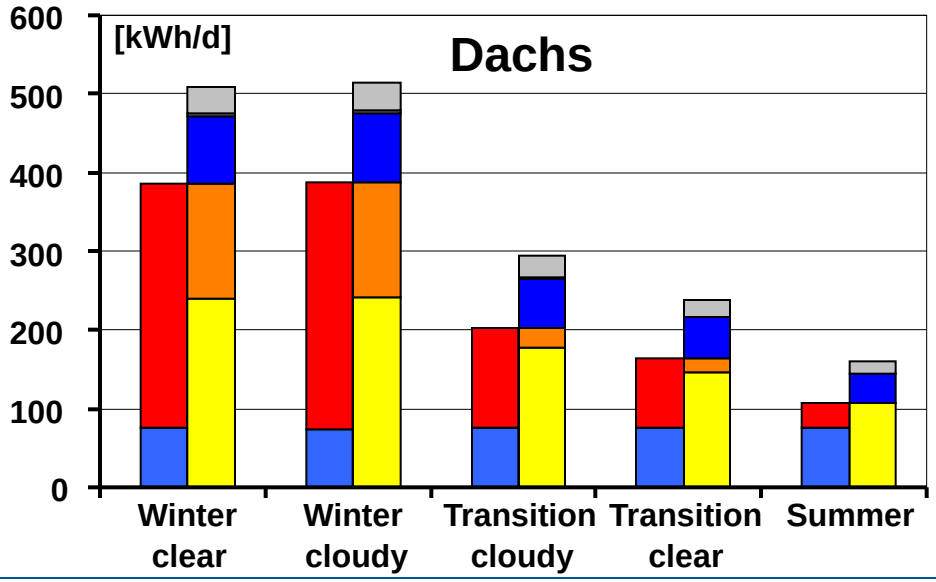


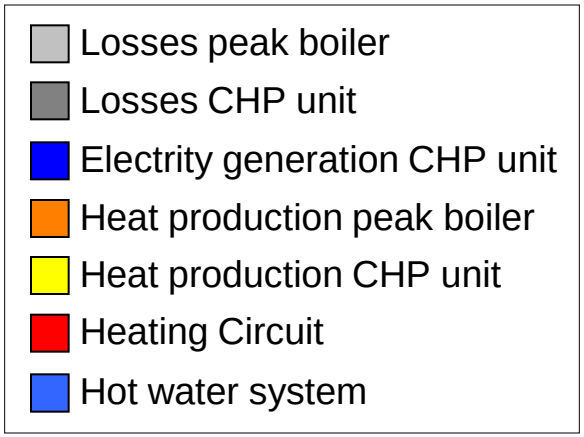
# Results of Type Day Measurements





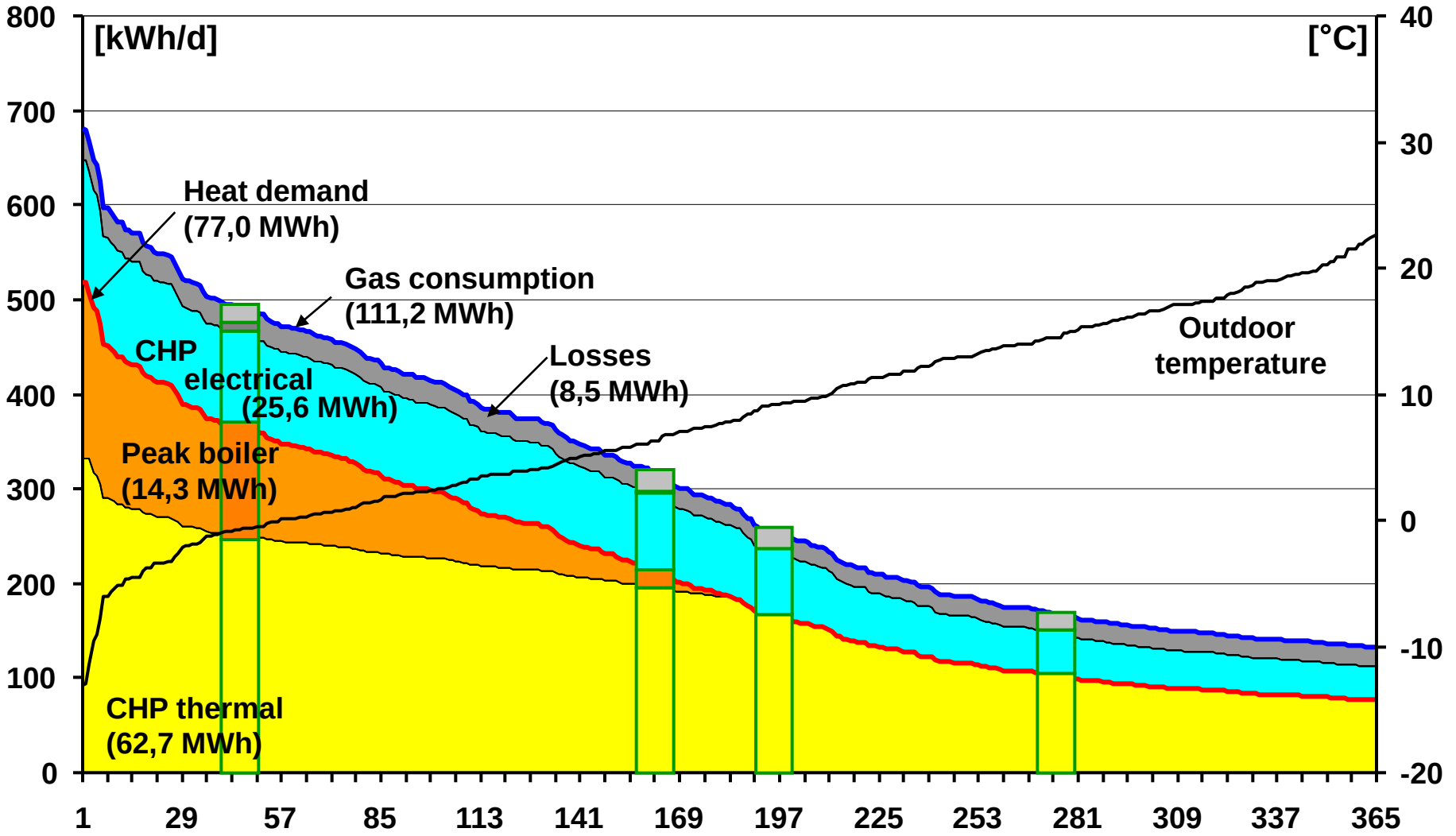




Corrected from influence of test stand

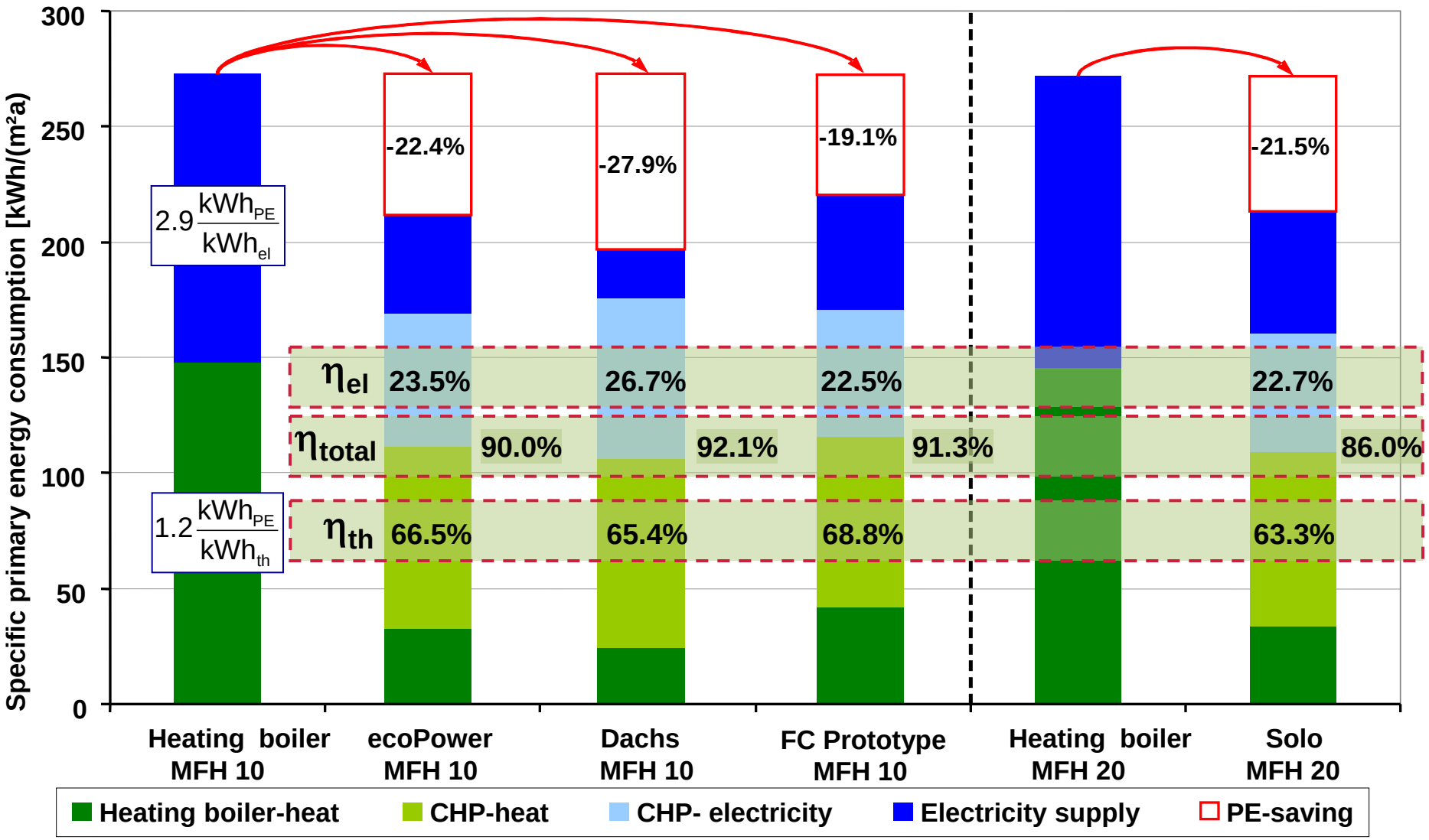
# Duration Curve of Demand and Generation





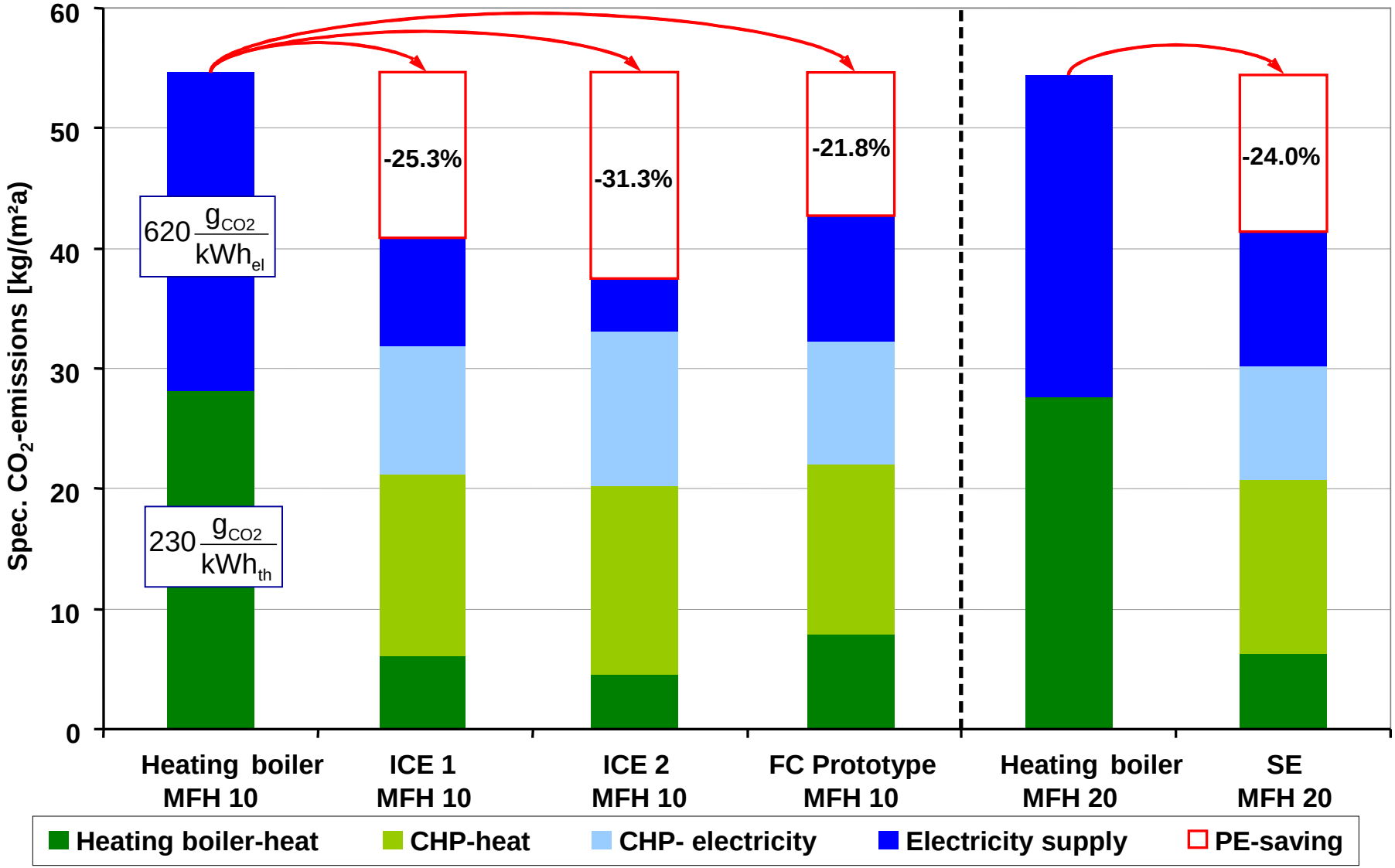
# Primary Energy Consumption





# $CO_2$-Emissions





# Field Testing Campaign



# Some words on the Set up

- Cooperation with local gas utility

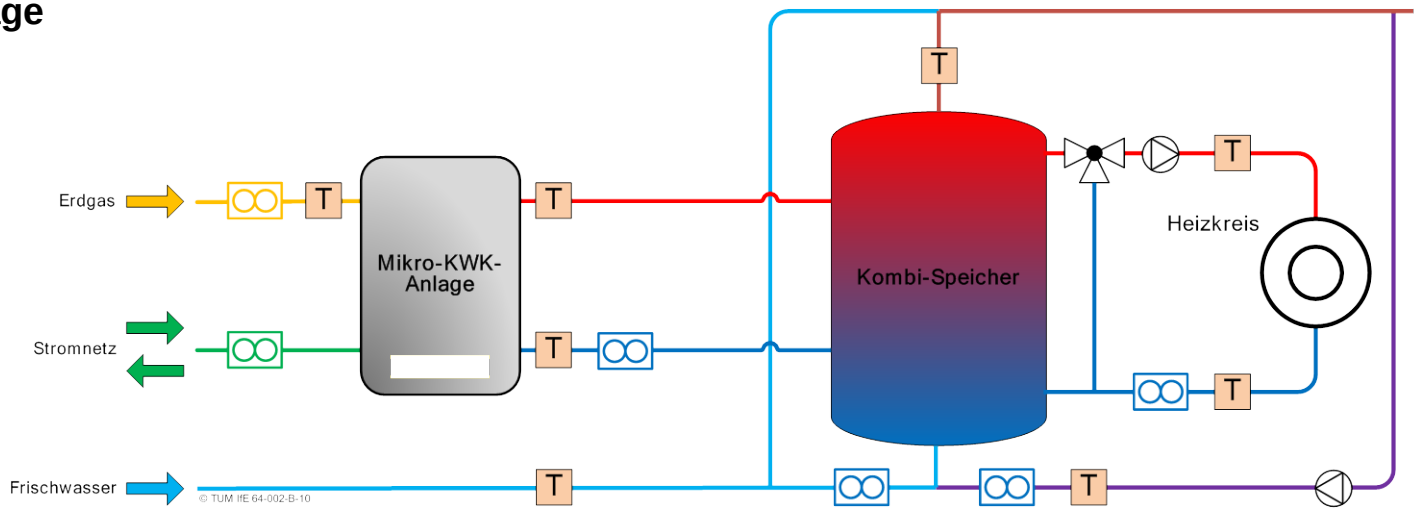
- Field trial was announced in newspapers
  -> 1,200 applications
    -> 800 met the parameters

- 4 were chosen
  - Systems were given for free
  - except a contribution of 1,500 € for the installation

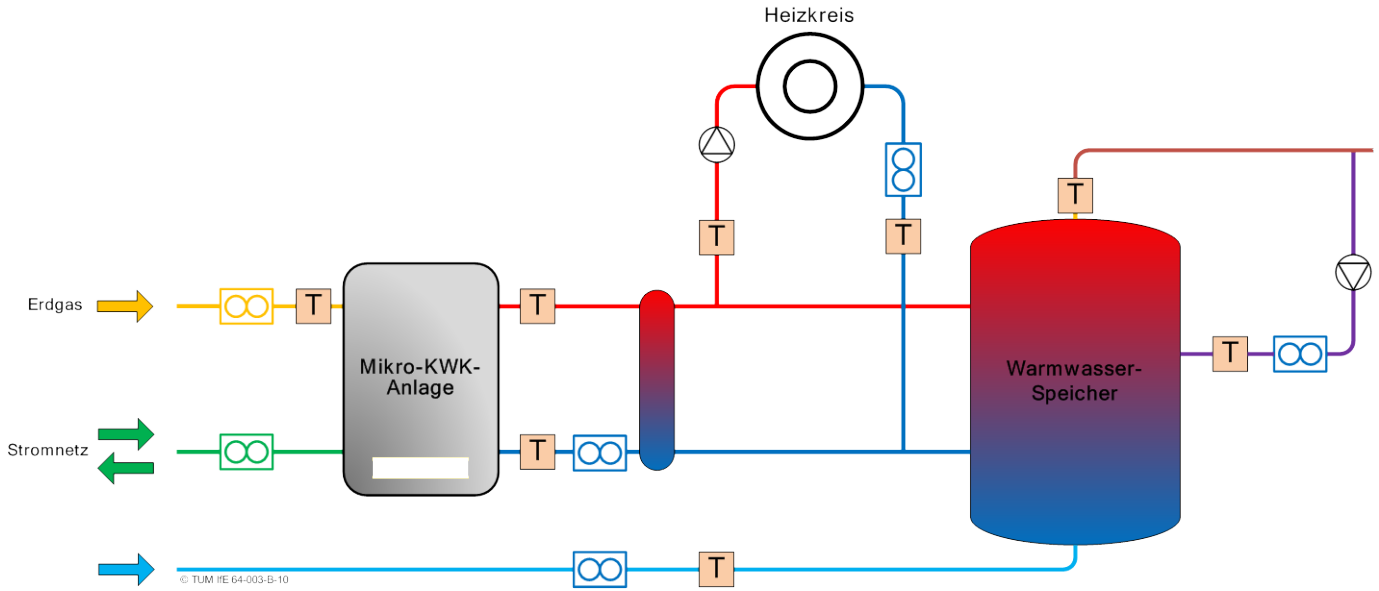
- TUM integrated measuring equipment
  - all relevant parameters
  - remote access via internet

# System Integration

## A: Combined Storage

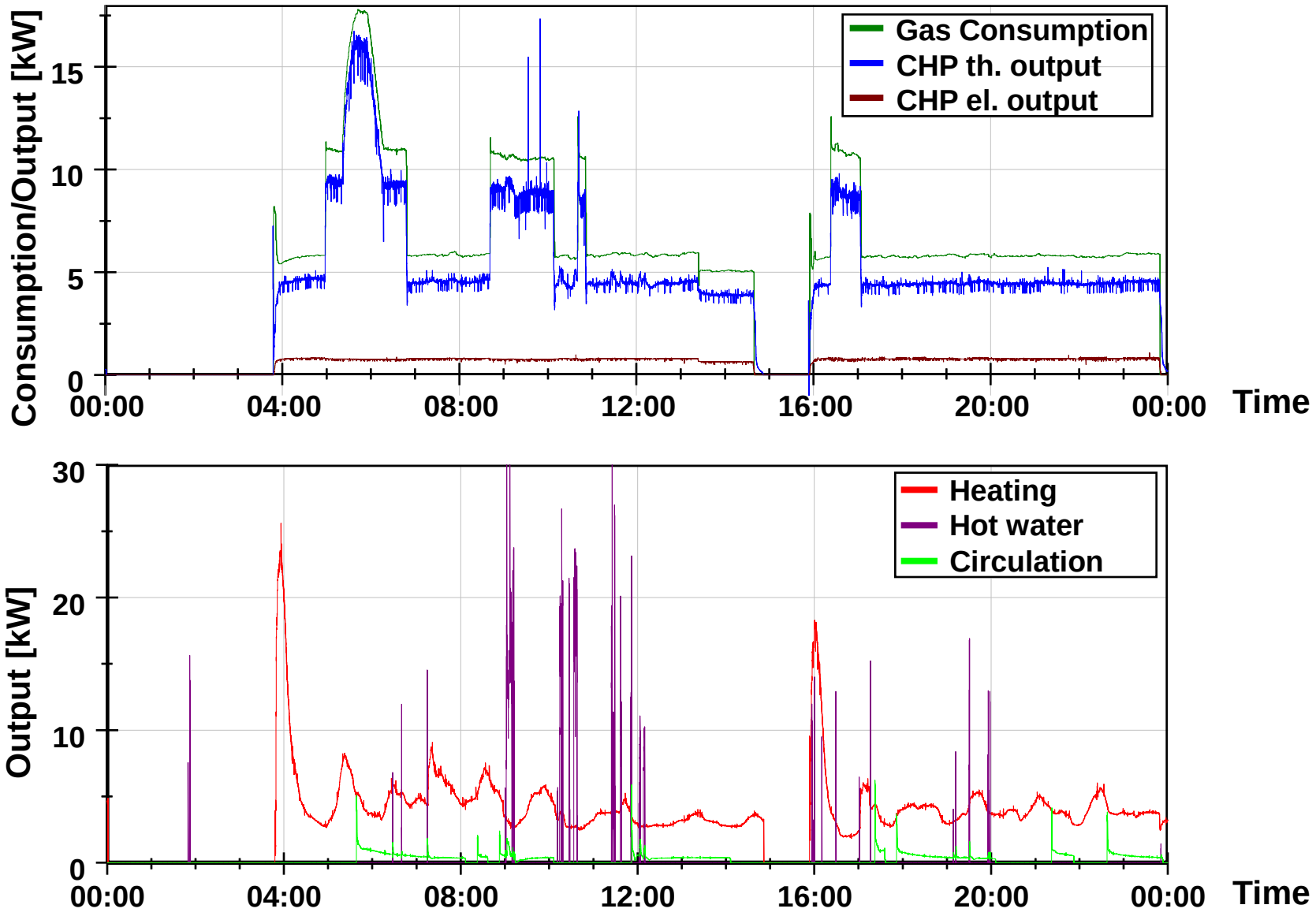



## B: DHW Storage



# µCHP Operation during a Winter Day





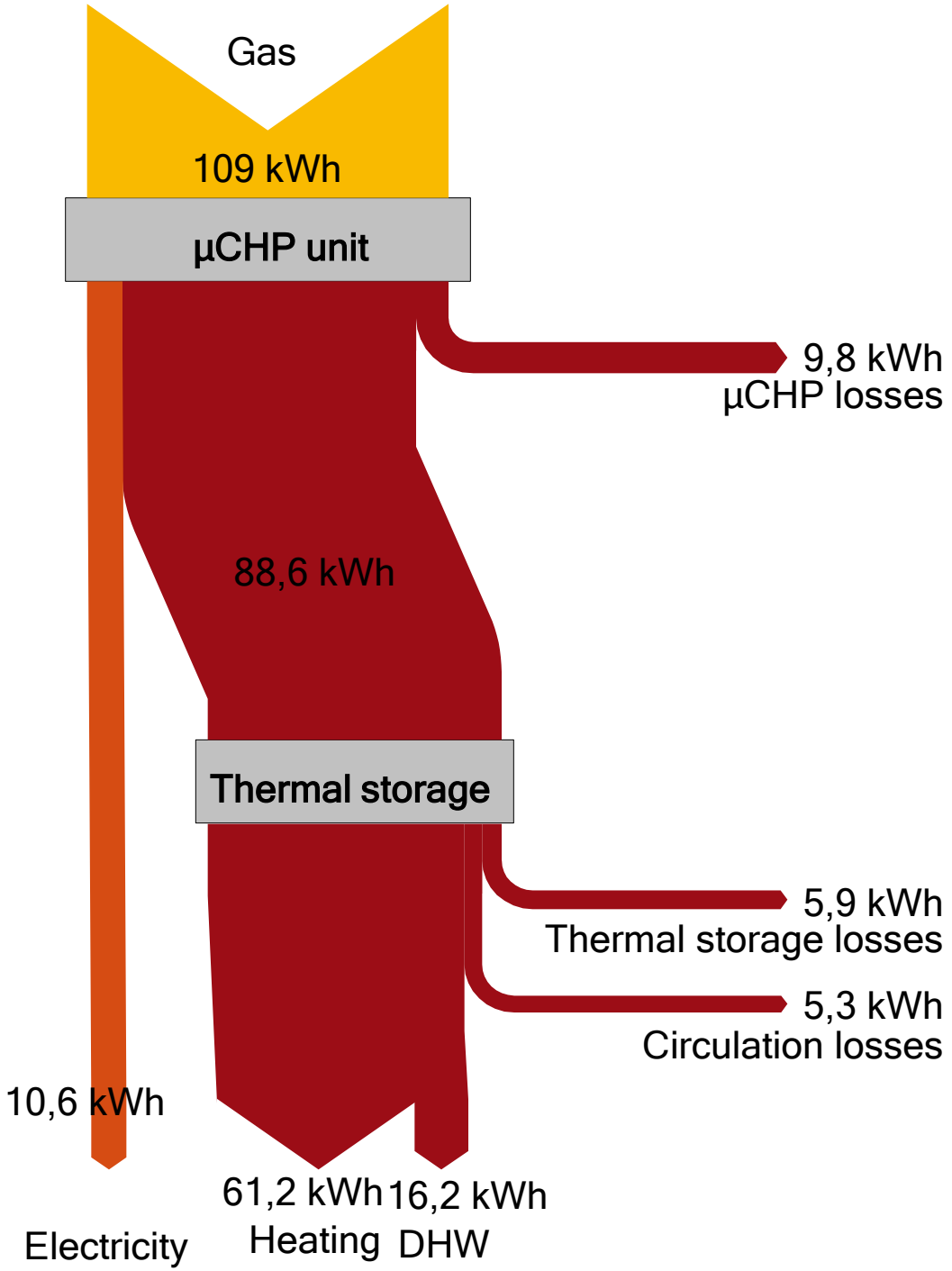
# µCHP Usage on a Winter

## µCHP unit

- 81% thermal efficiency
- 10% electrical efficiency
- 91% total efficiency

## Total System

- 71% thermal efficiency
- 10% electrical efficiency
- 81% total efficiency



# Results of Field Tests



| | System 1* | System 2 | System 3 | System 4 |
|---|---|---|---|---|
| Time period [h] | 2,124 | 4,342 | 4,388 | 4,363 |
| Gas Consumption [kWh] | 3,920 | 21,938 | 17,335 | 17,582 |
| El. Generation [kWh] | 282 | 2,288 | 1,726 | 1,944 |
| Heat output [kWh] | 3,215 | 18,576 | 14,041 | 14,001 |
| Electrical efficiency** - | 7% | 10% | 10% | 11% |
| Thermal efficiency - | 82% | 85% | 81% | 80% |
| Total efficiency - | 89% | 95% | 91% | 91% |
| On-Site use - | 71% | 61% | 34% | 83% |

* short runtime due to technical problems

** related to total gas conumption, incl. aux. burner

- Systems working very reliable
- Operation can be optimized

# Short Summary

- People are very interested in producing their own electricity
- µCHP systems are highly efficient
- Systems are (so far) very reliable
- Potential for optimization of control strategies

# Thank you for your Attention