LEXU II

Einsatz von außenliegender Wandtemperierung für die Gebäudesanierung

izes gGmbH
Institut für ZukunftsEnergie- und Stoffstromsysteme

LEXU II
„Low Exergy Wall & Air Tempering for Building Refurbishment"

>> **TRNSYS Experience Seminar 2018**

Belval (Luxembourg) 20.04.2018

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Ein Projekt von

ENERGIEWENDEBAUEN

Forschung für energieoptimierte Gebäude und Quartiere

Research project LEXU II
External wall tempering

Motivation, contents und work packages

Research project LEXU II
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Motivation, contents und work packages

Refurbishment „from the outside“

LowEx-Approach

Utilization of low temperature waste heat

Outlying/external wall tempering (aWT): special case of TABS

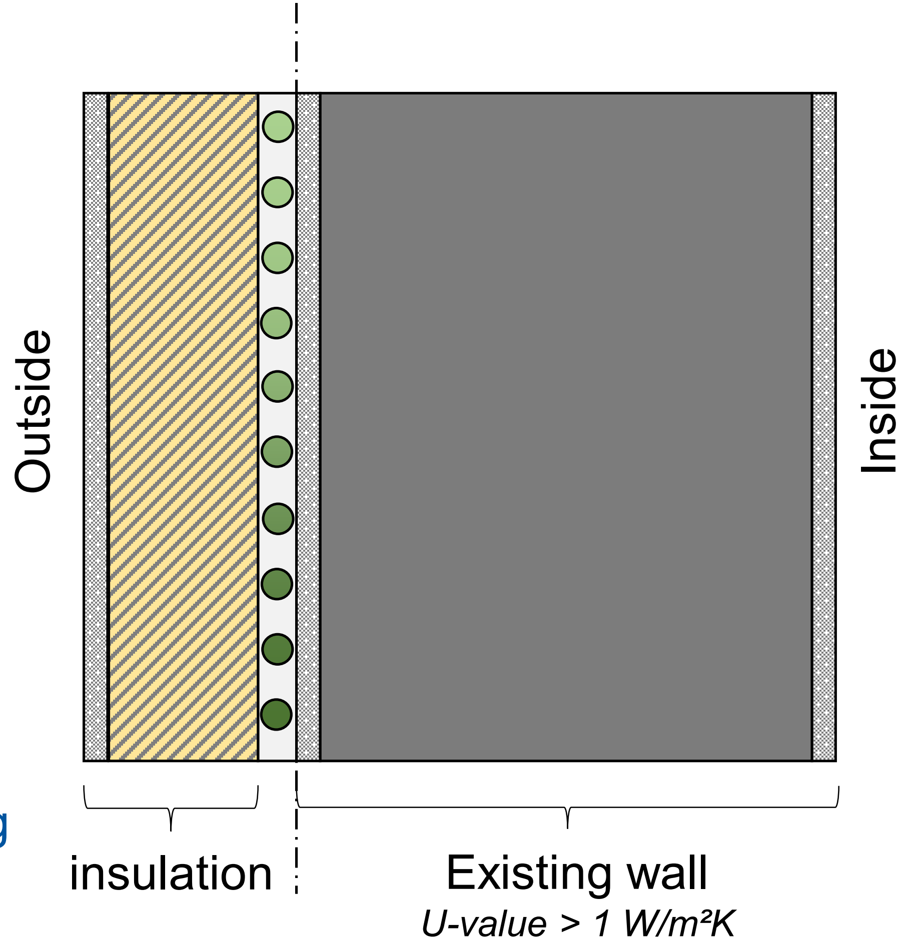
1) Installation of panel heating/tempering „from the outside“

2) Installation of an ETICS (WDVS)

Position of the panel heating:

Inside of the thermal envelope of the building, outside of the existing wall, in front of the ETICS

→ Panel heating for existing buildings & thermal acitvation for the existing building structure



Details:„Außenliegende Wandtemperierung“ – LowEx-Anwendung zur Temperierung von Bestandsgebäuden und thermischen Aktivierung der Bestandswand: Theoretische Grundlagen und Kennwerte; Schmidt, C., Altgeld, Luther, Maas, Scholzen.; in Bauphysik 39 (2017), Heft 4, S.215-223

- Advantages and disadvantages of the aWT
- **Advantages**:
- Thermal bridges / building damages
- Heating and cooling possible
- Increase of the inner surface temperature
  → *thermal comfort*
- Usage of very low fluid temperatures
  → LowEx
- Thermal acitvation of the existing building structure → storage
- Refurbishmant „from the outside“ (without impairment for the inhabitants) → minimally invasive

- **Disadvantages**:
- Additional heat losses
  → Efficiency of the aWT
- Slow heating system.
  - → Focus: control strategies
  - → „base load heating“
- „New“ on-site build system:
  - „new“ and many interfaces
  - „new“ and many sources of error

Research project LEXU II
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Research project LEXU II
External air tempering

Motivation, contents and work packages

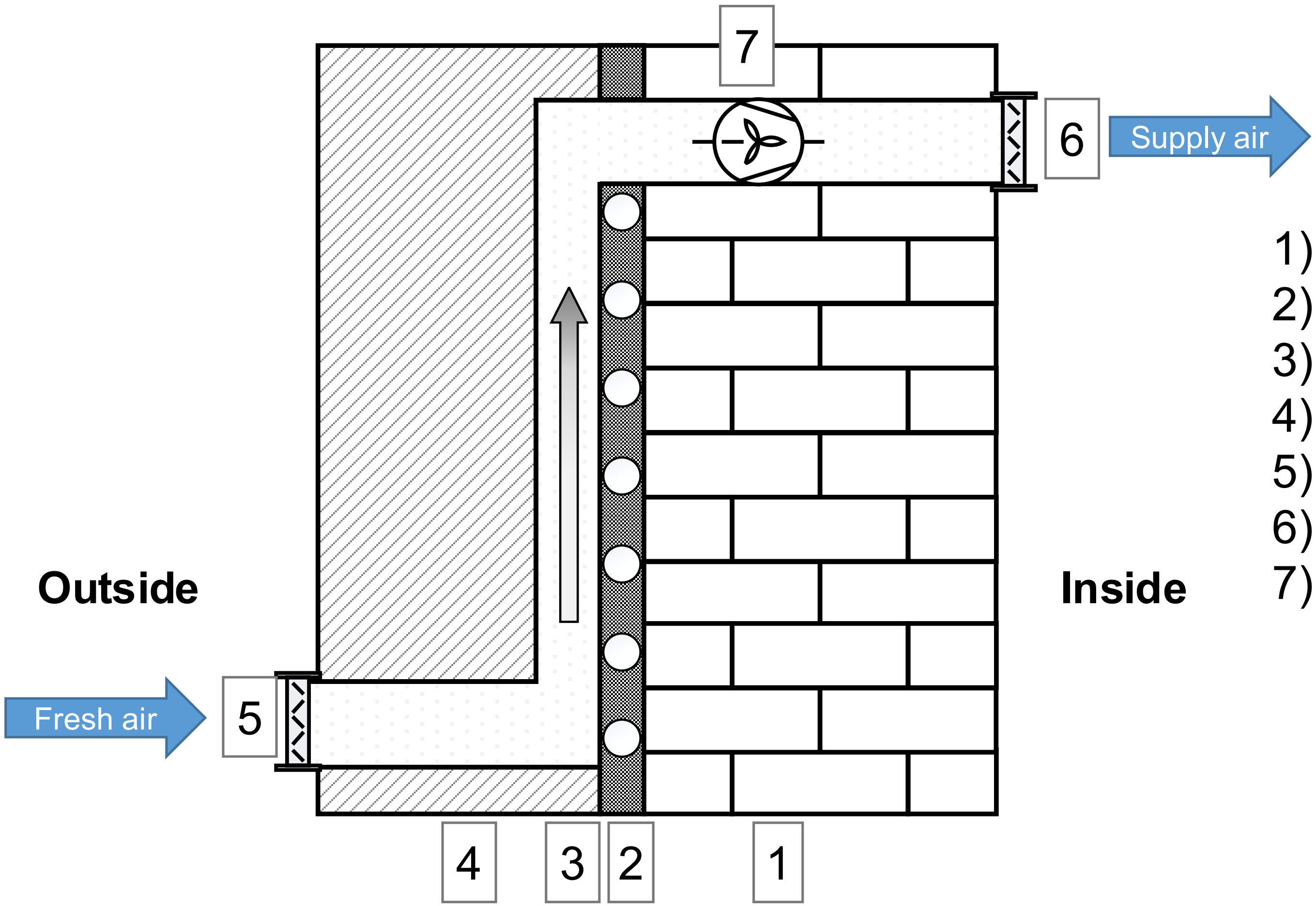
Refurbishment „from the outside“

Reducing the (addtional) heat losses/ Increase of efficiency

Reducing of the heat load for the aWT by tempering the supply air with the aLT

Fast system

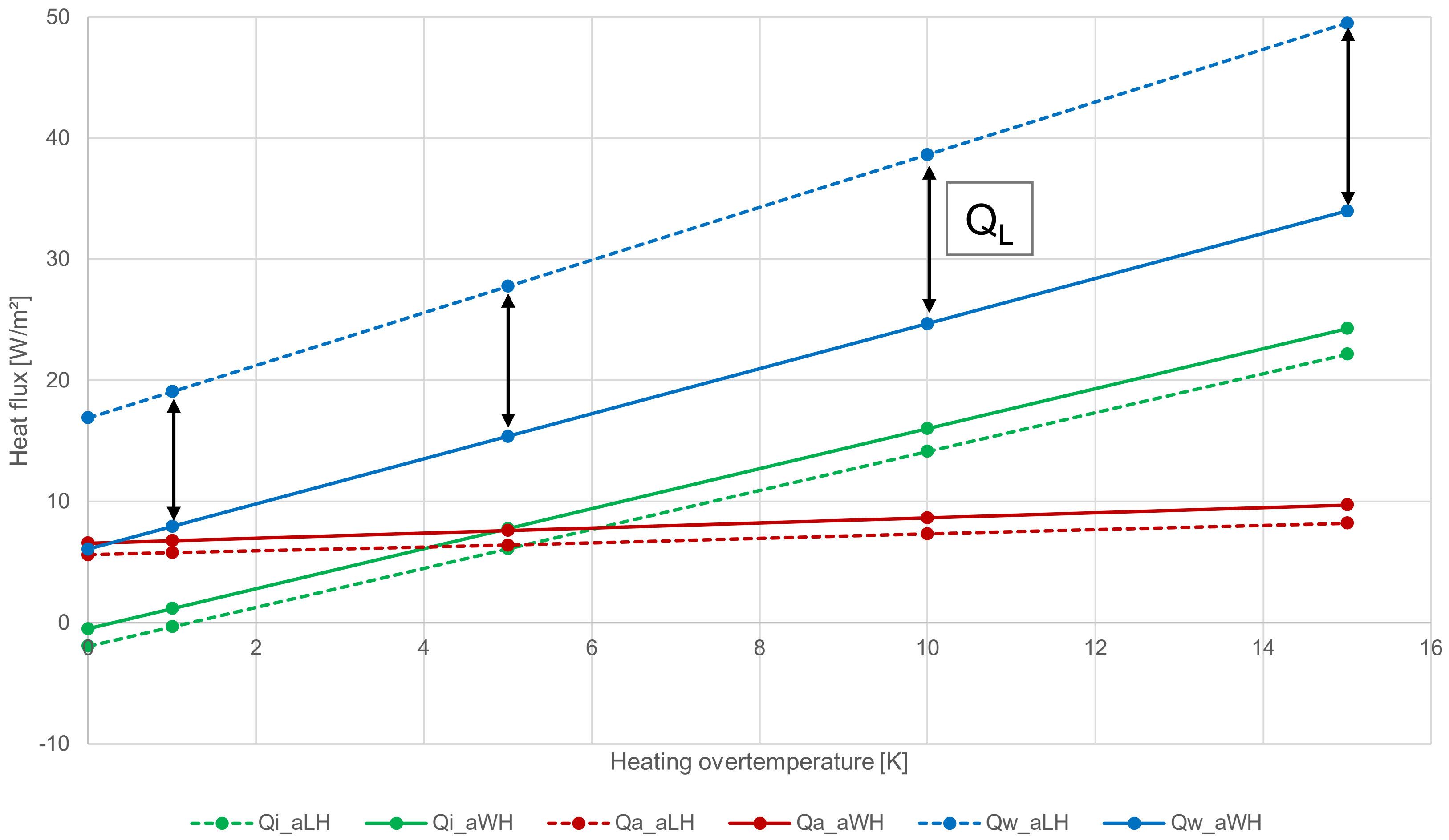
External air tempering (aLT)



1) Existing wall
2) Active Layer
3) Air Gap
4) ETICS
5) Air inlet (hatch/filter)
6) Air outlet (hatch/filter)
7) Fan (Rohreinschub-)

External air tempering (aLT)

Exemplary comparison aWT – aLT (referred to 20°C room temperature):



Results generated with TRNSYS 17

Energetic advantages:

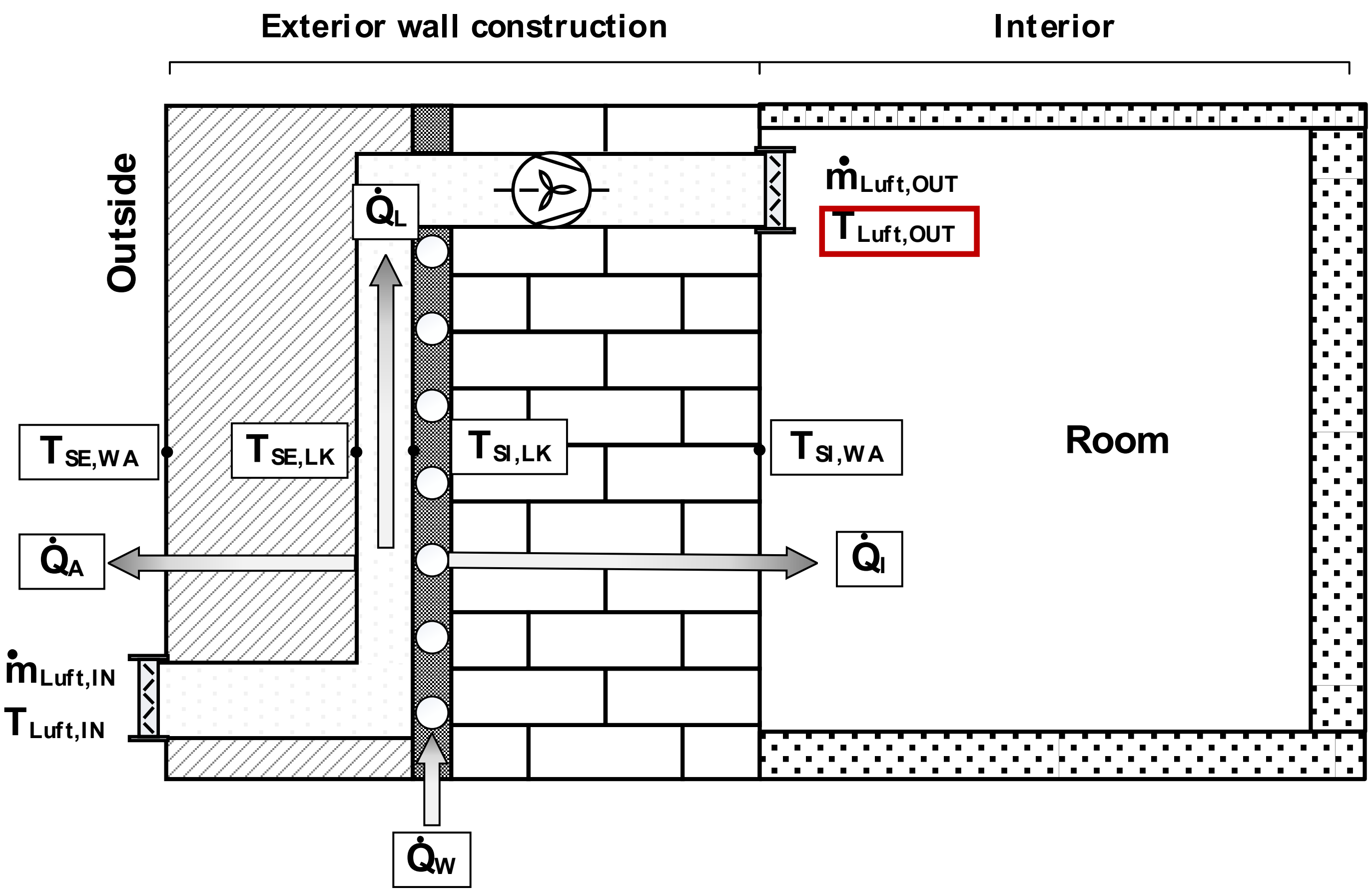
- The aLT (air) is like an additional heat transfer surface within the wall structure
- The efficiency can be increased by reducing the losses over the thermal insulation layer
- The importance of ventilation increases by an energetic refurbishment (higher tightness of the thermal envelope). By an combination of aWT & aLT the heat load can be complete covered

Positive control effects:

The slow adjustable aWT will be ideally or perfectly complemented by the quickly adjustable aLT.

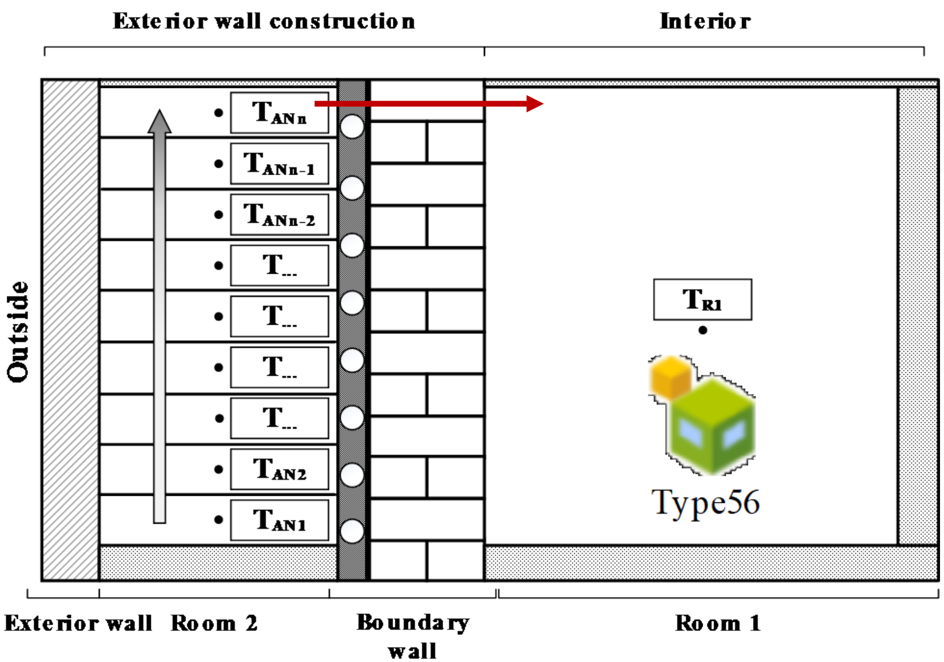
→ Base Load + Peak Load possible.

- Modeling of the aLT in TRNSYS
  - Energetic examination and futher simulations (fluid dynamics simulation in ANSYS)



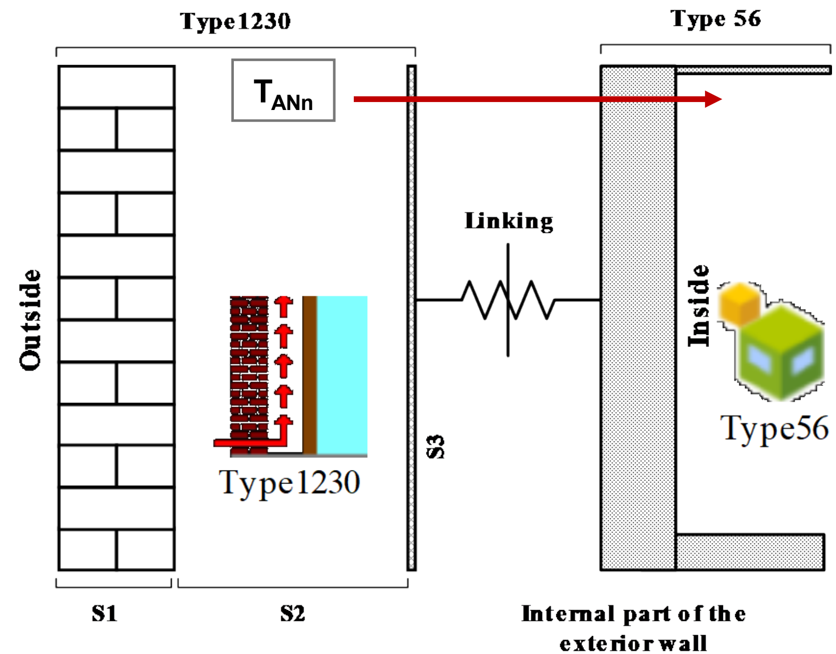
Modeling of the aLT in TRNSYS: Two possibilities

Multi-zone (airnode) approach in Type 56



Conclusion:
Similar simulations results to Type 1230 and to the measurement results from the test wall; BUT very high input effort (up to 128 airnodes) and high error rate (lots of linkings) → no further considerations

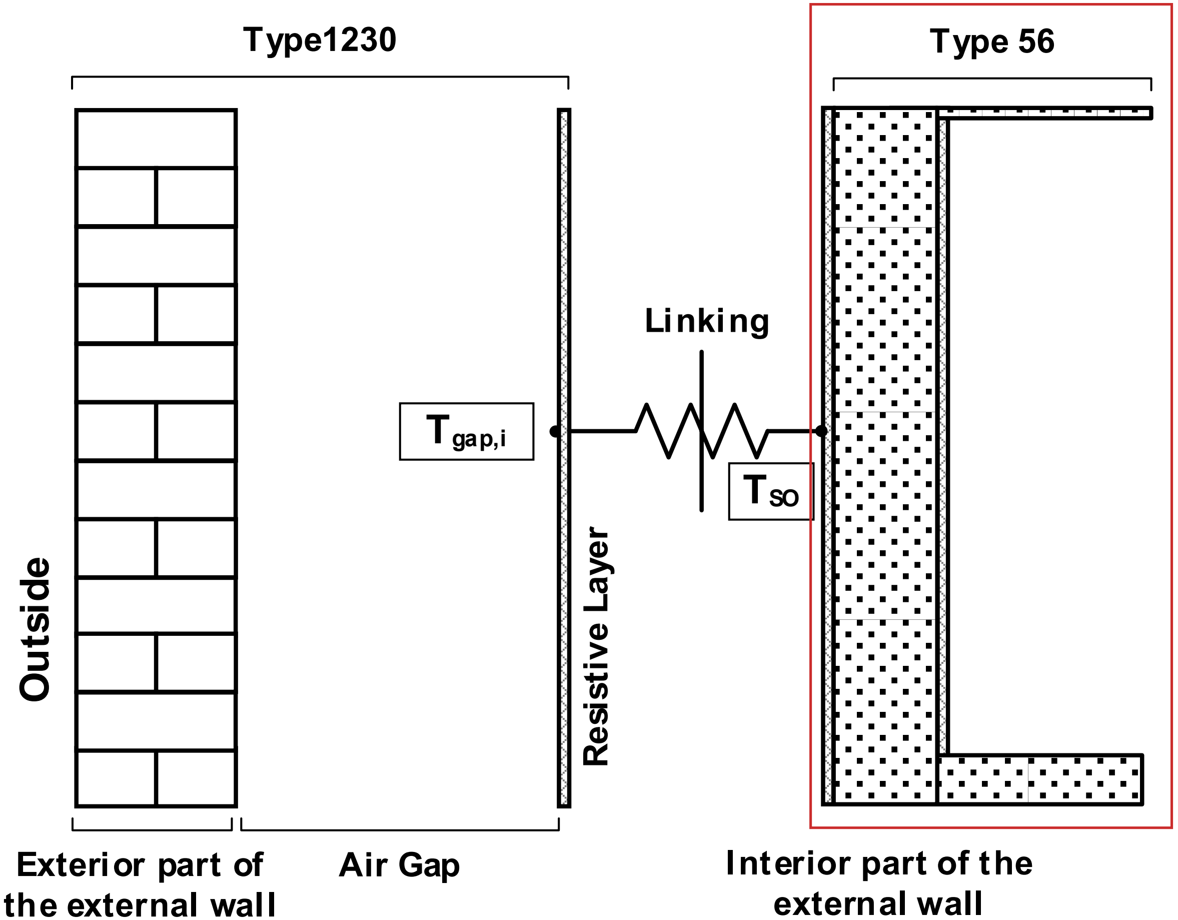
Type 1230: Ventilated Facade (TESS)



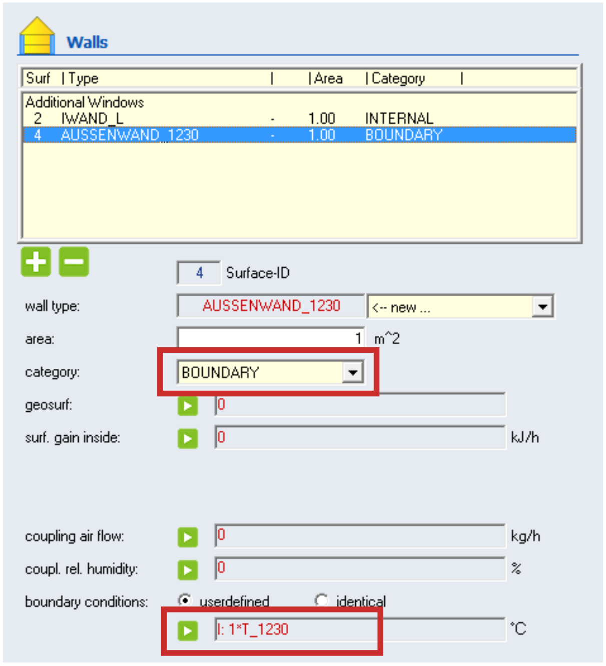
Conclusion:
Less input effort. Division of the thermal envelope between Type 56 and Type 1230.
Tricky linking beetween Type 1230 and Type 56

Bachelor-Thesis: Modellierung einer außenliegenden Luftheizung mit Hilfe der Software TRNSYS…, Daniel Schmidt, htw saar, 2013

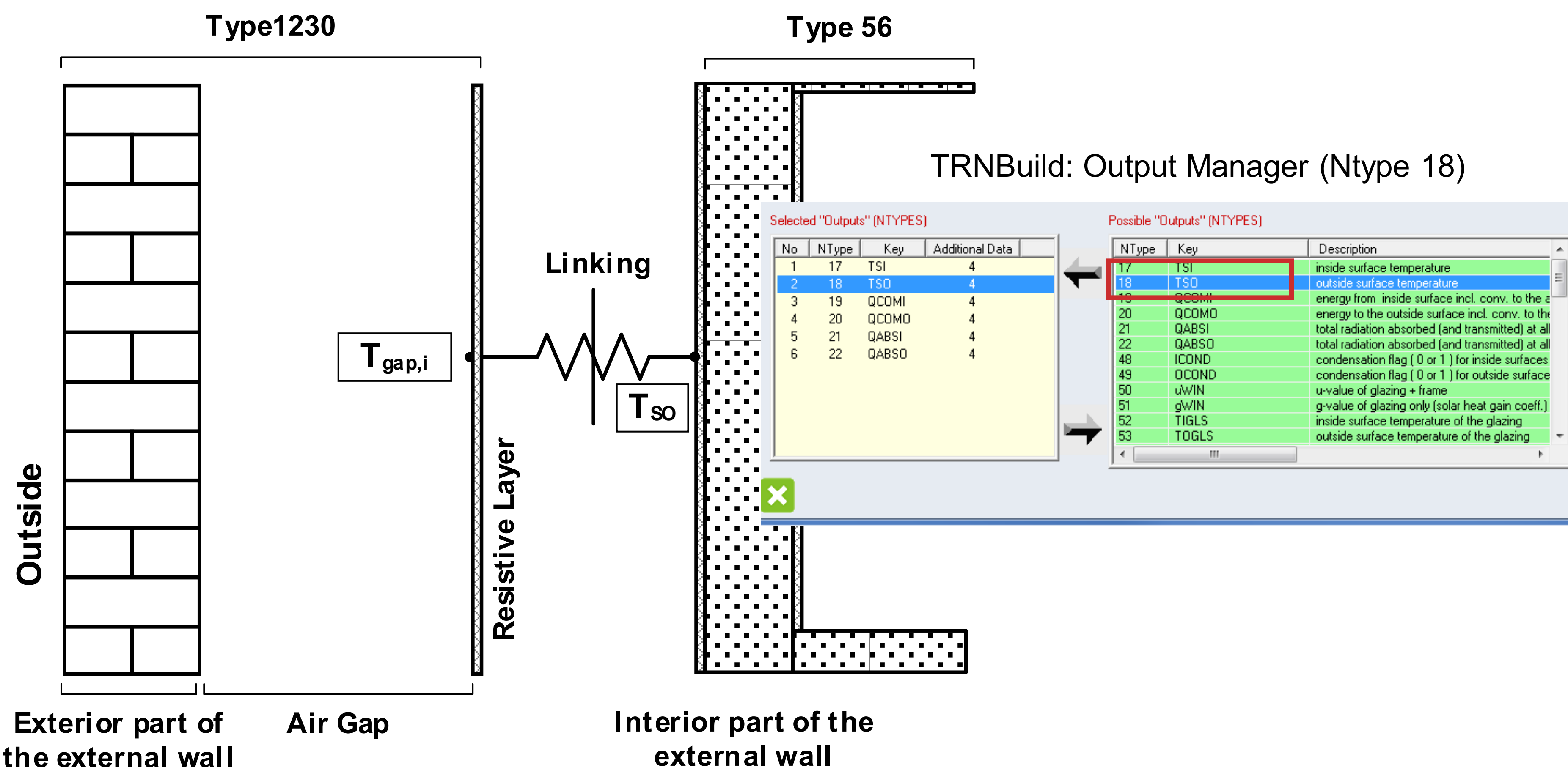
Linking between Type 1230 und Type 56



TRNBuild: Zone XY / Airnode XY



Linking between Type 1230 und Type 56



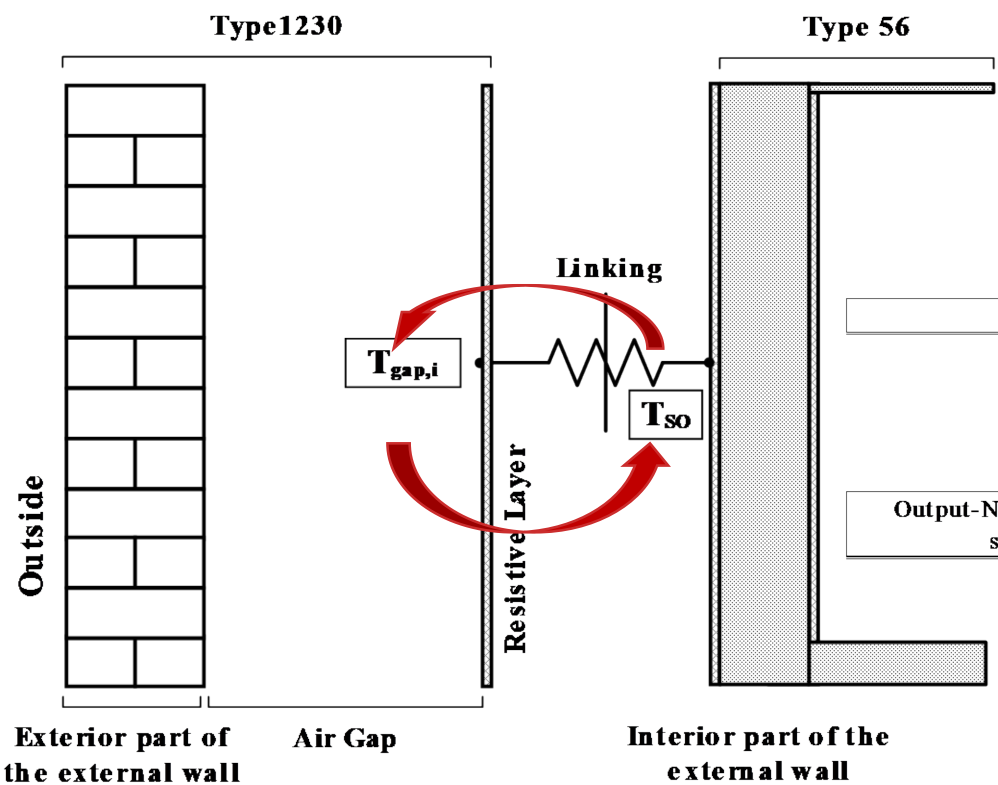
Selected "Outputs" (NTYPES)

No	NType	Key	Additional Data
1	17	TSI	4
2	18	TSO	4
3	19	QCOMI	4
4	20	QCOMO	4
5	21	QABSI	4
6	22	QABSO	4

Possible "Outputs" (NTYPES)

NType	Key	Description
17	TSI	inside surface temperature
18	TSO	outside surface temperature
19	QCOMI	energy from inside surface incl. conv. to the a
20	QCOMO	energy to the outside surface incl. conv. to the
21	QABSI	total radiation absorbed (and transmitted) at all
22	QABSO	total radiation absorbed (and transmitted) at all
48	ICOND	condensation flag (0 or 1) for inside surfaces
49	OCOND	condensation flag (0 or 1) for outside surface
50	uWIN	u-value of glazing + frame
51	gWIN	g-value of glazing only (solar heat gain coeff.)
52	TIGLS	inside surface temperature of the glazing
53	TOGLS	outside surface temperature of the glazing

Linking between Type 1230 und Type 56



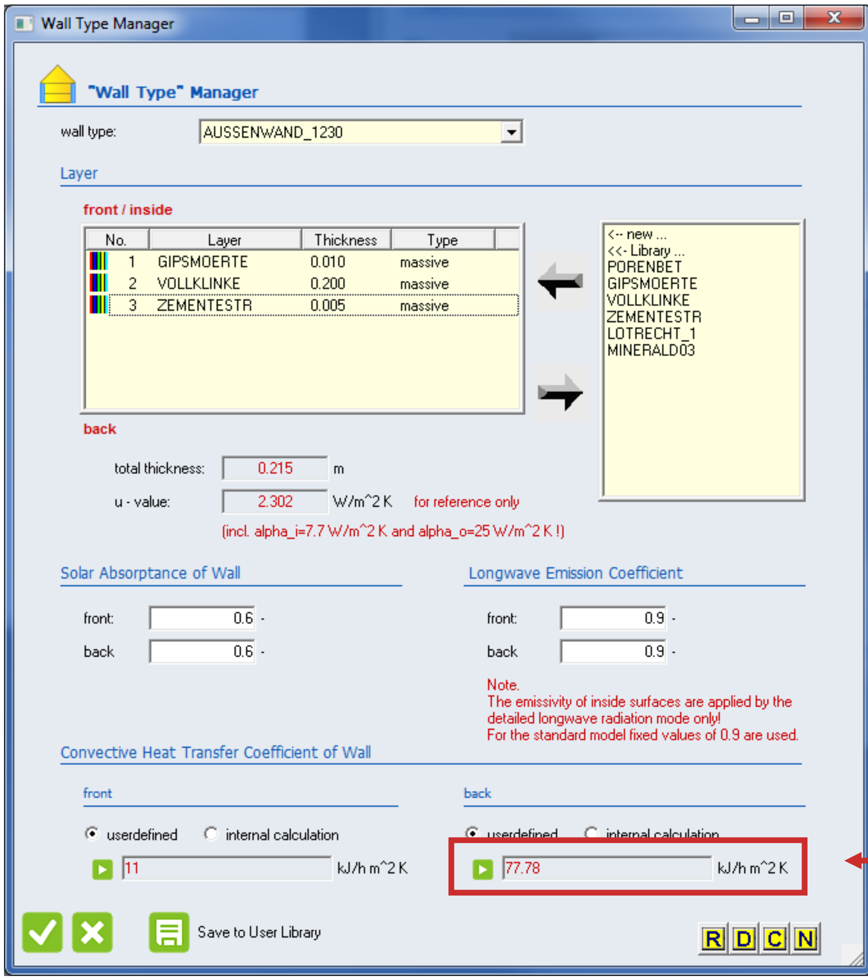
Simulation Studio

Type56 → Type1230	
TSO_ID (hier ID4)	Input-Nr. 6: Back surface temperature

Type1230 → Type56	
Output-Nr. 7: Average interior air gap surface temperature	Input "Boundary Condtions" (hier "T_1230")

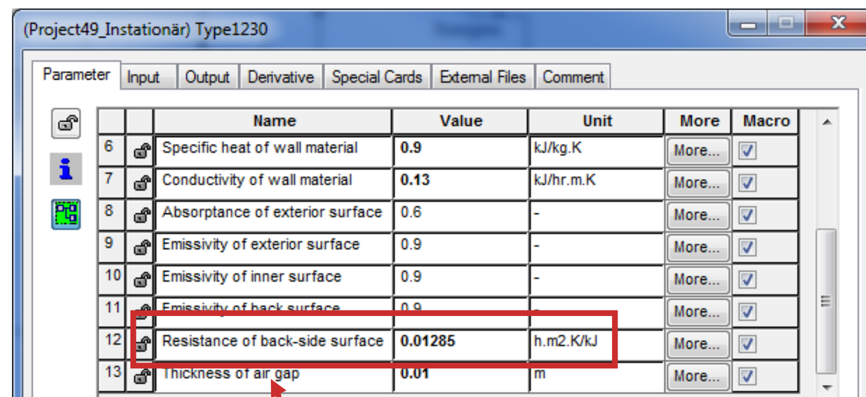
Linking between Type 1230 und Type 56

TRNBuild: Wall Type Manager



Definition of the resistive layer

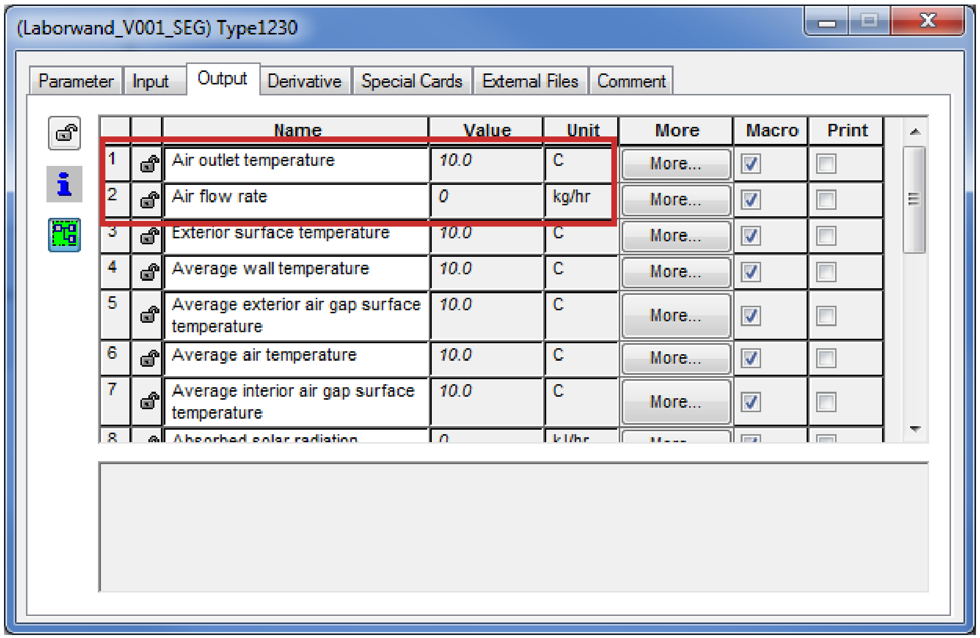
Type 1230: Parameter



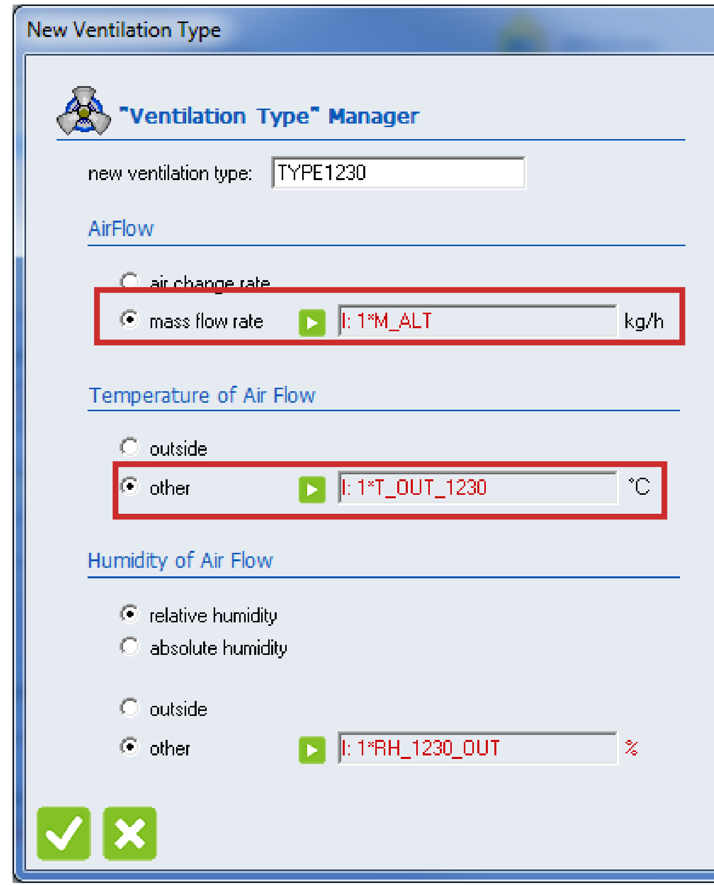
Inverse

Linking between Type 1230 und Type 56 (for the aLT)

Type 1230: Output

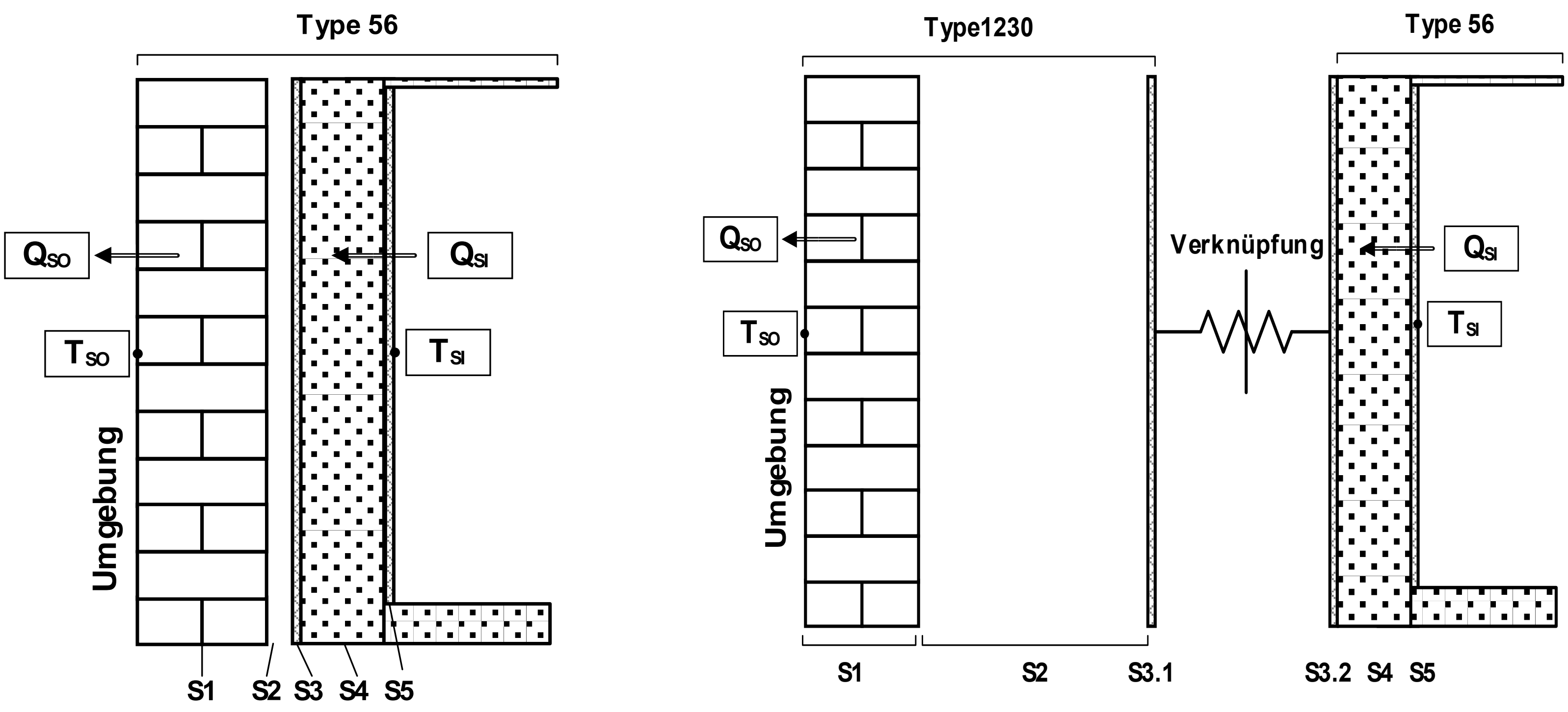


TRNBuild: Ventilation Type Manager

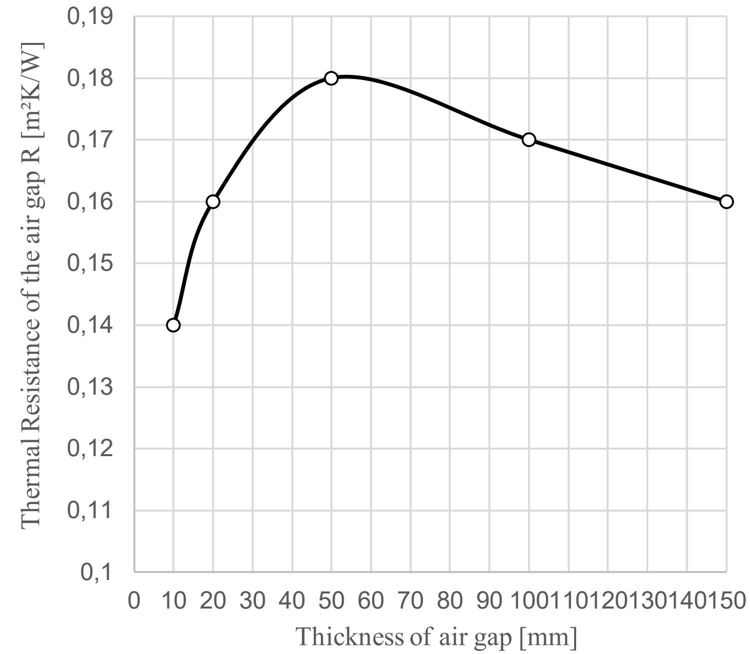


Verification of Type 1230

Comparison of an external wall with air layer (non ventilated) in Type 56 and Type 1230 + Type 56



- Verification of Type 1230
  - Stationary conditions
  - Transient conditions
  - With/without irradiation
  - Variation of the thickness of the air gap

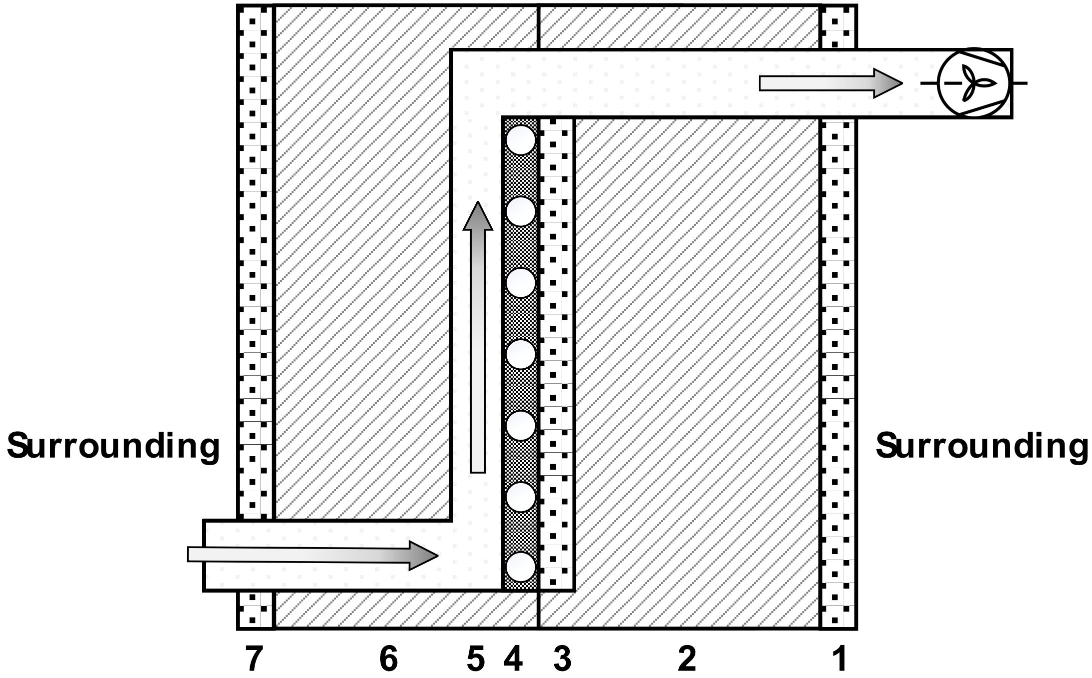


Summary:
Differences <2% could be determined across all simulations and variations.

Model	Tsi [°C]	Tso [°C]	Qsi [W]	Qso [W]
Type 56	19,28	0,162	3,54	3,54
Type 56+ Type 1230	19,29	0,159	3,49	3,49

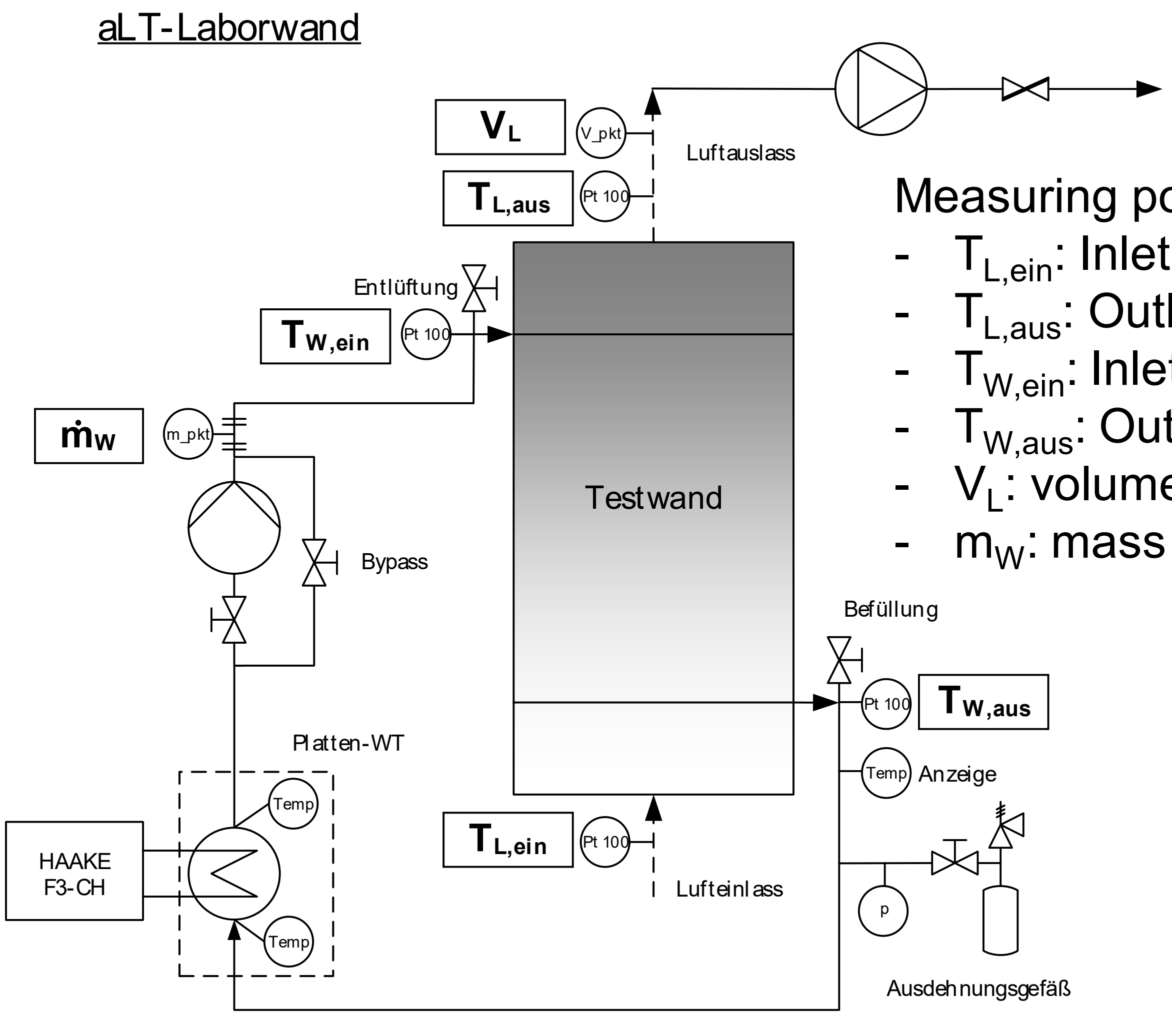
Quelle: Recknagel/Sprenger, 07/08

Laboratory wall / test bench of the aLT



Nr.	Description	Thickness
1	Wood-fiberboard	18 mm
2	Insulation (Polystyrene)	160 mm
3	Wood-fiberboard	10 mm
4	Capillary tubes: acitve layer	10 mm
5	Air gap	20 mm
6	Insulation (Polystyrene)	160 mm
7	Wood-fiberboard	18 mm

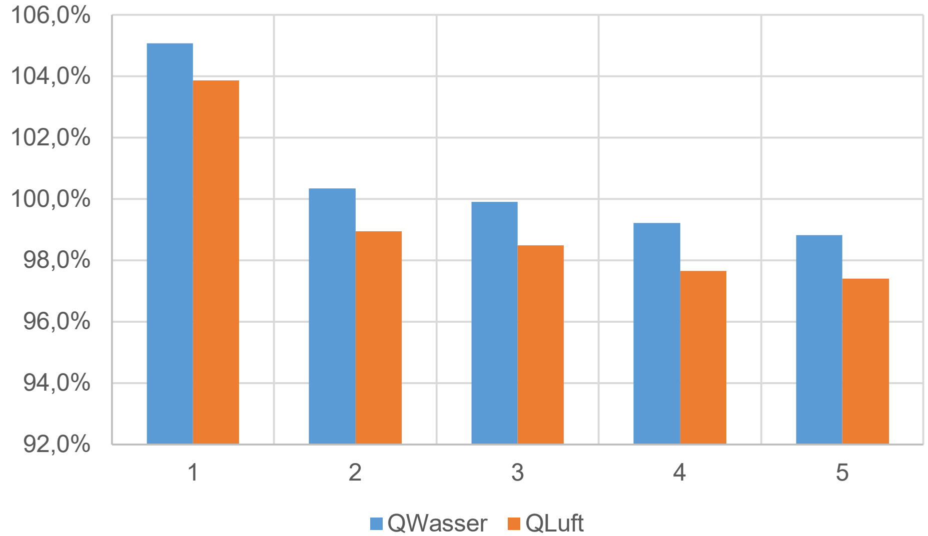
Laboratory wall / test bench of the aLT



Measuring points:

- $T_{L,ein}$: Inlet temperature „air" [°C]
- $T_{L,aus}$: Outlet temperatur „air" [°C]
- $T_{W,ein}$: Inlet temperature „water" [°C]
- $T_{W,aus}$: Outlet temperature „water" [°C]
- V_L: volume flow air [m³/s]
- m_W: mass flow water [kg/min]

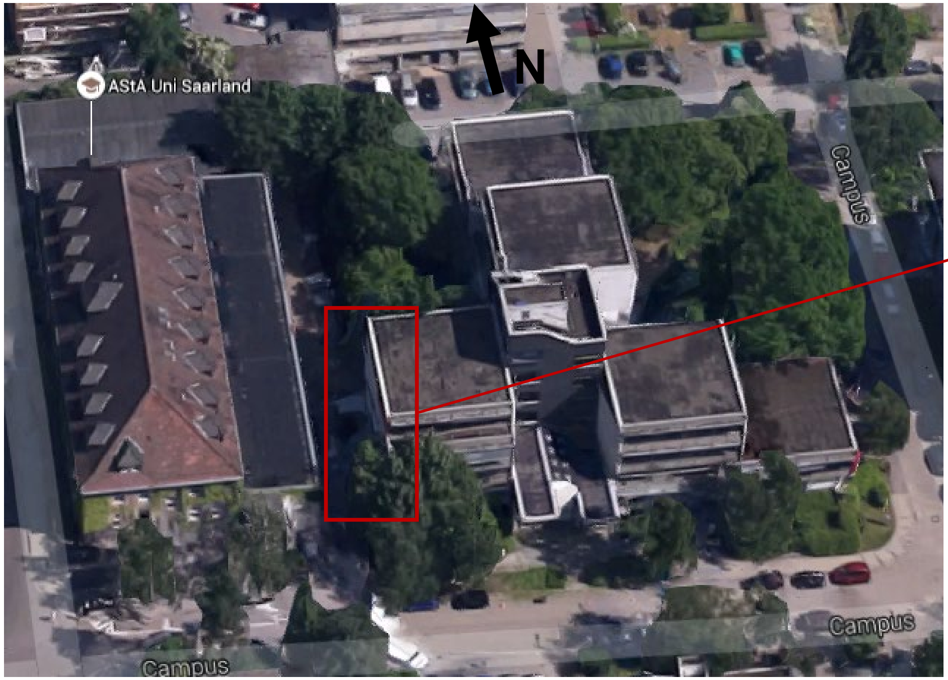
- Laboratory wall / test bench of the aLT
  - Validation of Type 1230
    - Comparison between measured data and simulation results
    - Detailed evaluation and validation just in progress (>40 test series)
      → Paper BauSim 2018, Karlsruhe (?)



First Conclusion:
Good accordance of the measured data and the simulation results; differences ~5%

Documentation of a first validation for the aWT & aLT:
LEXU II – Einsatz von aussenliegender Wandtemperierung bei der Gebäudesanierung; Schmidt, C., Altgeld, Groß, Luther, Schmidt, D.; Proceedings of CESBP/BauSim 2016, Dresden

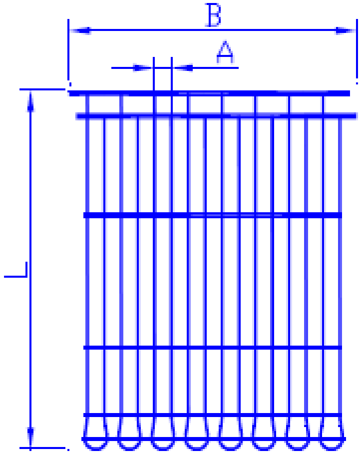
- Building C 3.1 on the campus of „ Universität des Saarlandes“
  - Year of construction: 1969



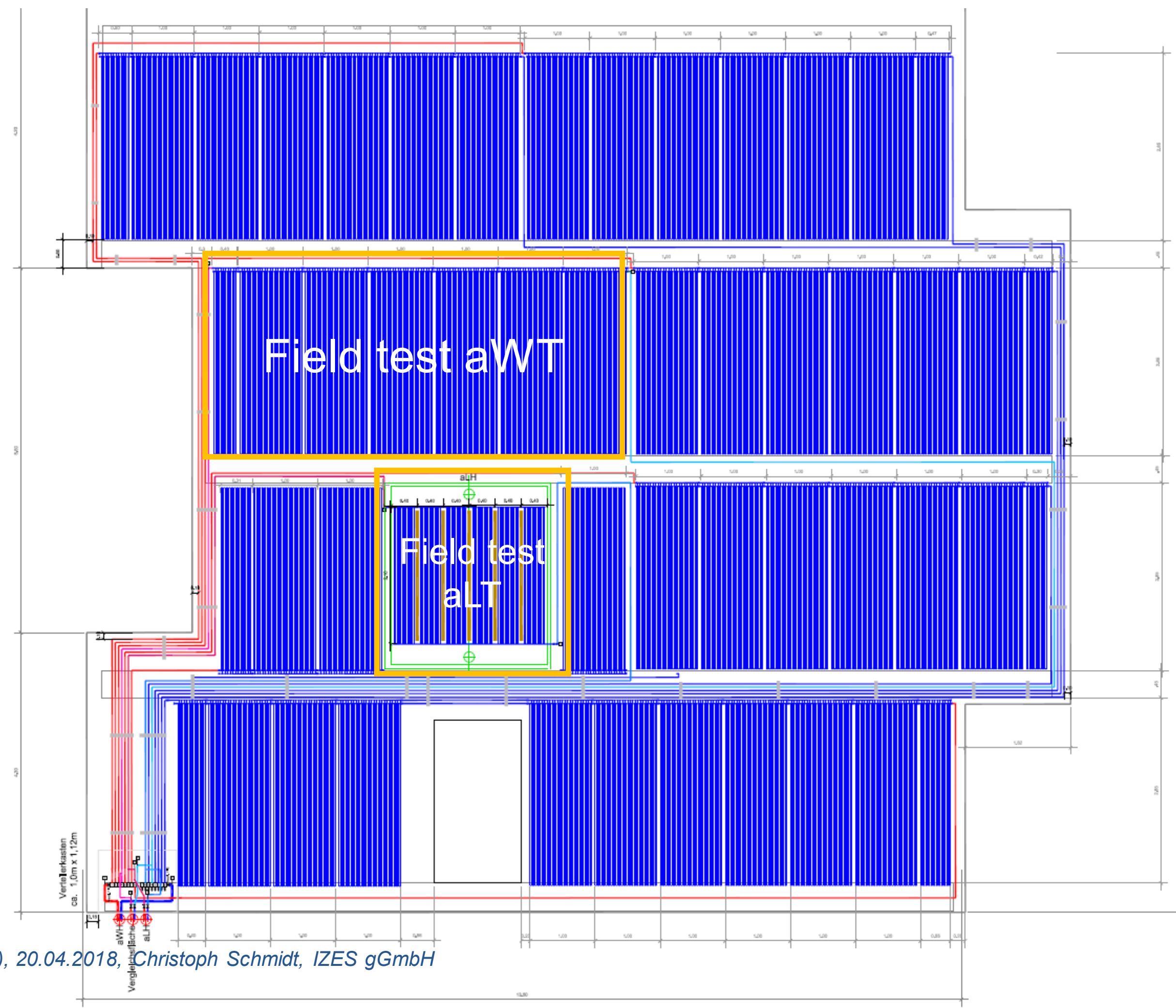
Quelle: Google Maps, 2017

- Western frontage
  - Height: ~15 m
  - Width: ~13,5 m
  - Area: ~200 m²
  - 0,36 m ferroconcrete (Stahlbeton)

- Detailed planning of the facade
- Idea: room-by-room control aWT + field test area aWT & aLT



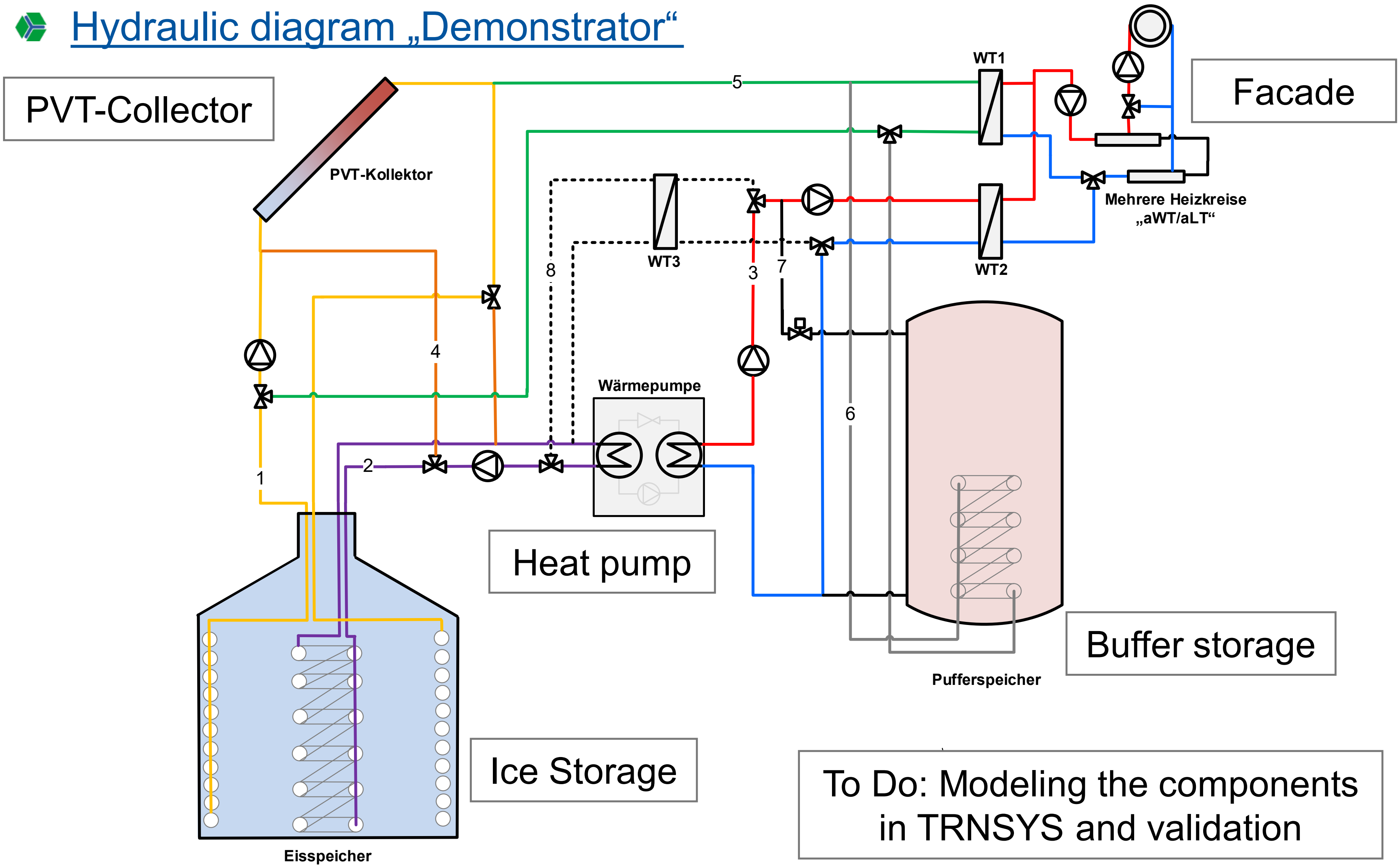
- Kapillarrohrmatte „Optimat SB 20“
- Hersteller: Clina, Berlin
- Stammrohr: 20 x 2 mm
- Kapillarrohr 4,3 x 0,8 mm
- Abstand A: 20 mm
- Länge: 60-600 mm
- Breite: ab 150 mm
- → Fertigung der Matten passend für die Fassade



Realization

Final step „Modeling of the aLT“: Validation of Type 1230 by a comparison with measured data from the field test area

Hydraulic diagram „Demonstrator“



To Do: Modeling the components in TRNSYS and validation

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Questions?

Many thanks to the funding authority, our project partner and supporters!

Project management	Project partner	Supporter	Funding
izes gGmbH Institut für ZukunftsEnergie- und Stoffstromsysteme SAARLAND Großes entsteht immer im Kleinen.	Clina Kapillarrohrtechnologie für Heiz- und Kühlsysteme Universität des Saarlandes Referat FM: Facility Management Kompetenzzentrum Ausbau und Fassade GEFGA Energiesysteme GmbH Viessmann WIDAG GbR Dr. Gerhard Luther	Knauf Kioto Solar Kostal wilo HGE Ingenieur GmbH	Gefördert durch: Bundesministerium für Wirtschaft und Energie aufgrund eines Beschlusses des Deutschen Bundestages

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