

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

>> TRNSYS Experience Seminar 2018

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Ein Projekt von

Research project LEXU II
External wall tempering
Motivation, contents und work packages

Research project LEXU II **External wall tempering**

Motivation, contents und work packages

*Refurbishment
„from the outside“*

LowEx-Approach

*Utilization of low temperature
waste heat*

LEXU II:

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

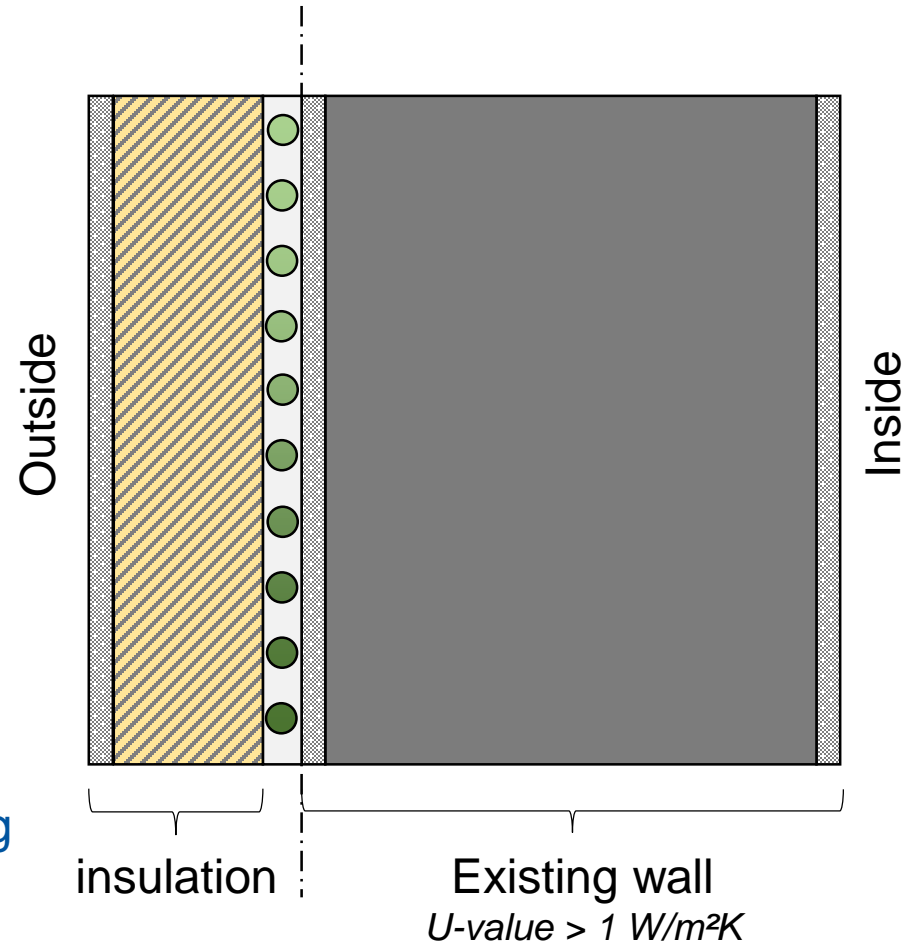
1) Installation of panel heating/tempering „from the outside“

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 activation 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

LEXU II:

❖ 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 activation of the existing building structure → storage
- ❖ Refurbishment „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
External air tempering
Motivation, contents und work packages

Research project LEXU II **External air tempering**

Motivation, contents and work packages

*Refurbishment „from the
outside“*

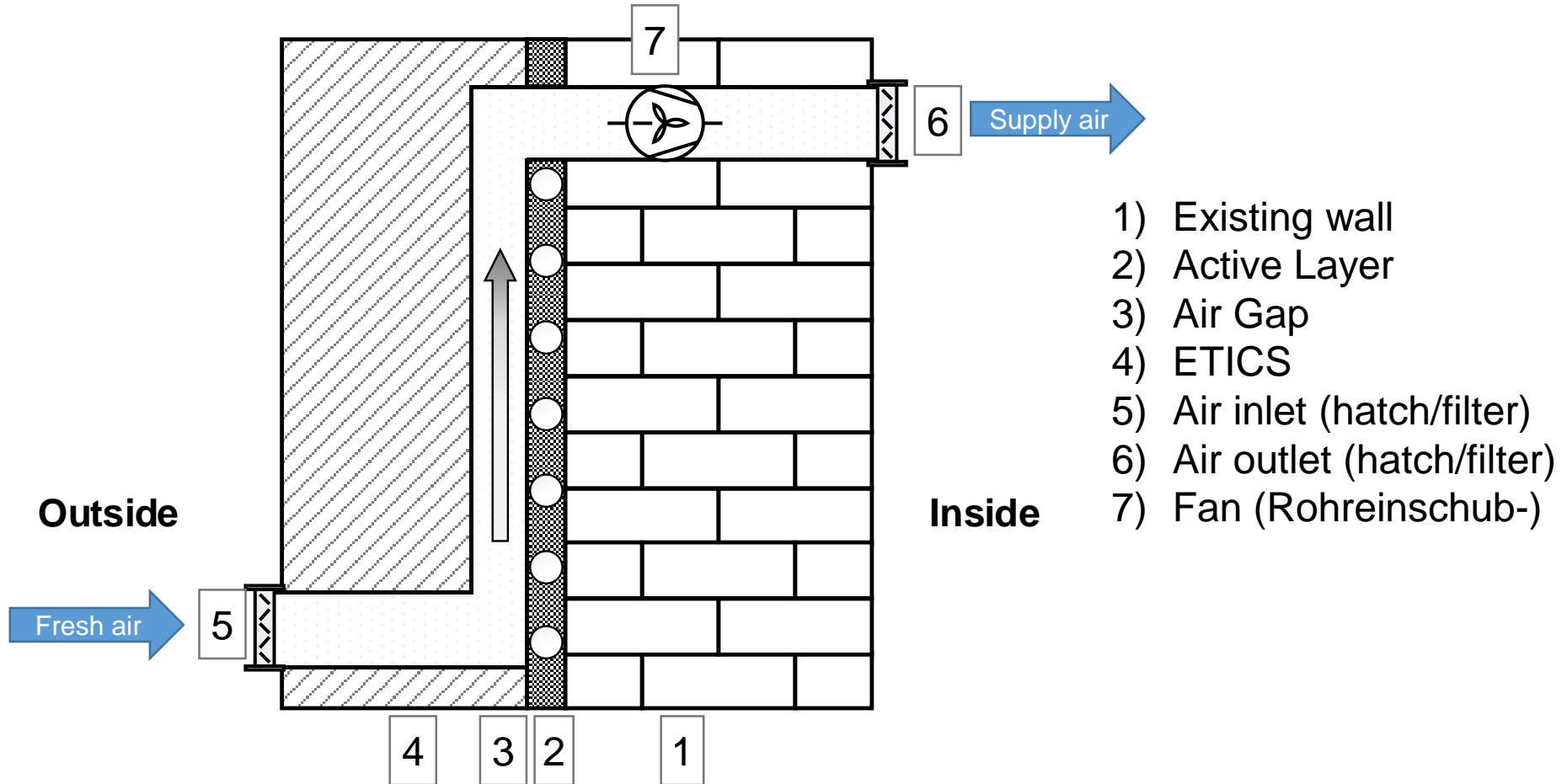
*Reducing of the heat load for
the aWT by tempering the
supply air with the aLT*

*Reducing the (additional) heat losses/
Increase of efficiency*

Fast system

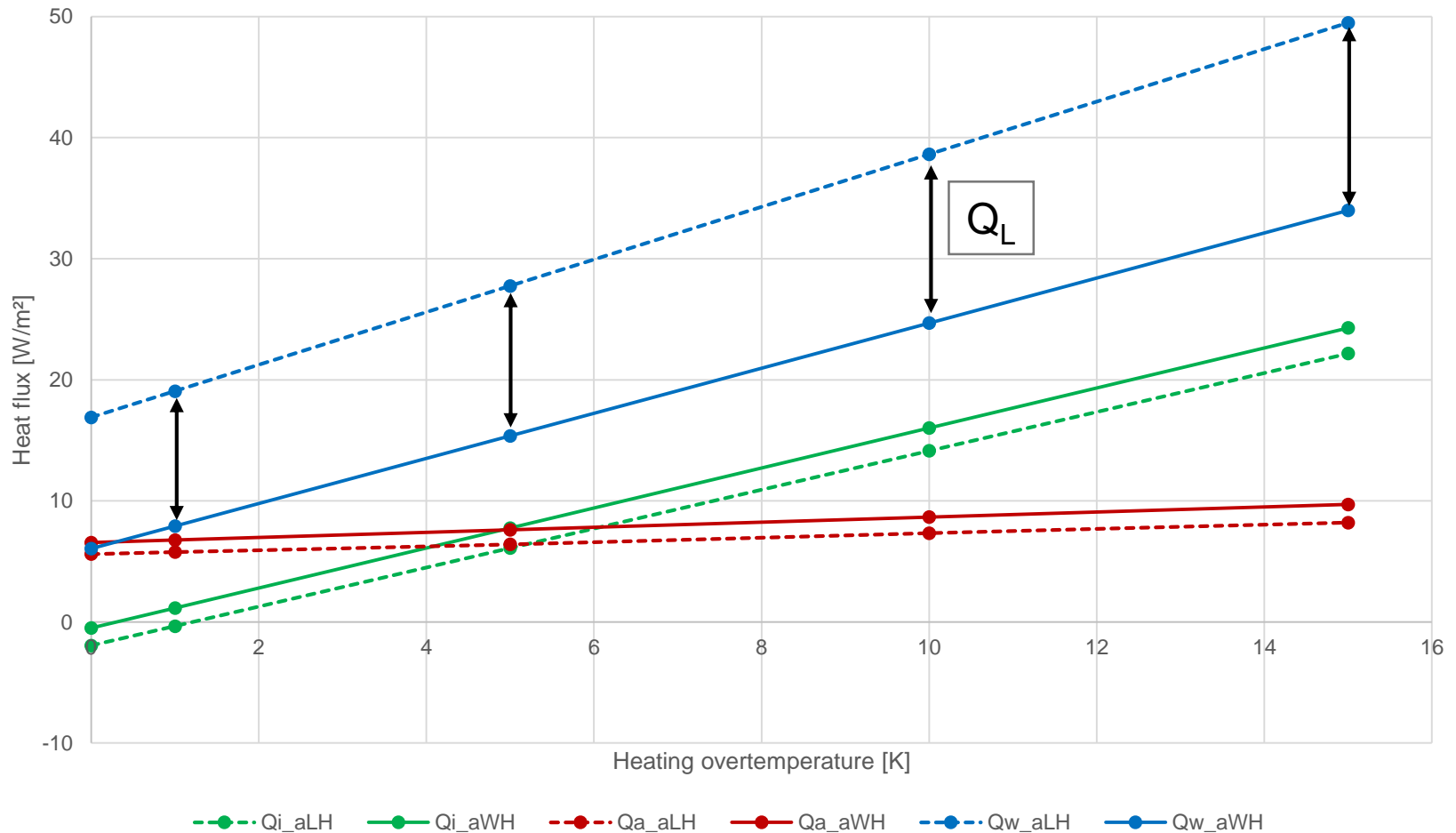
LEXU II:

External air tempering (aLT)



External air tempering (aLT)

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



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 a combination of aWT & aLT the heat load can be completely covered

Positive control effects:

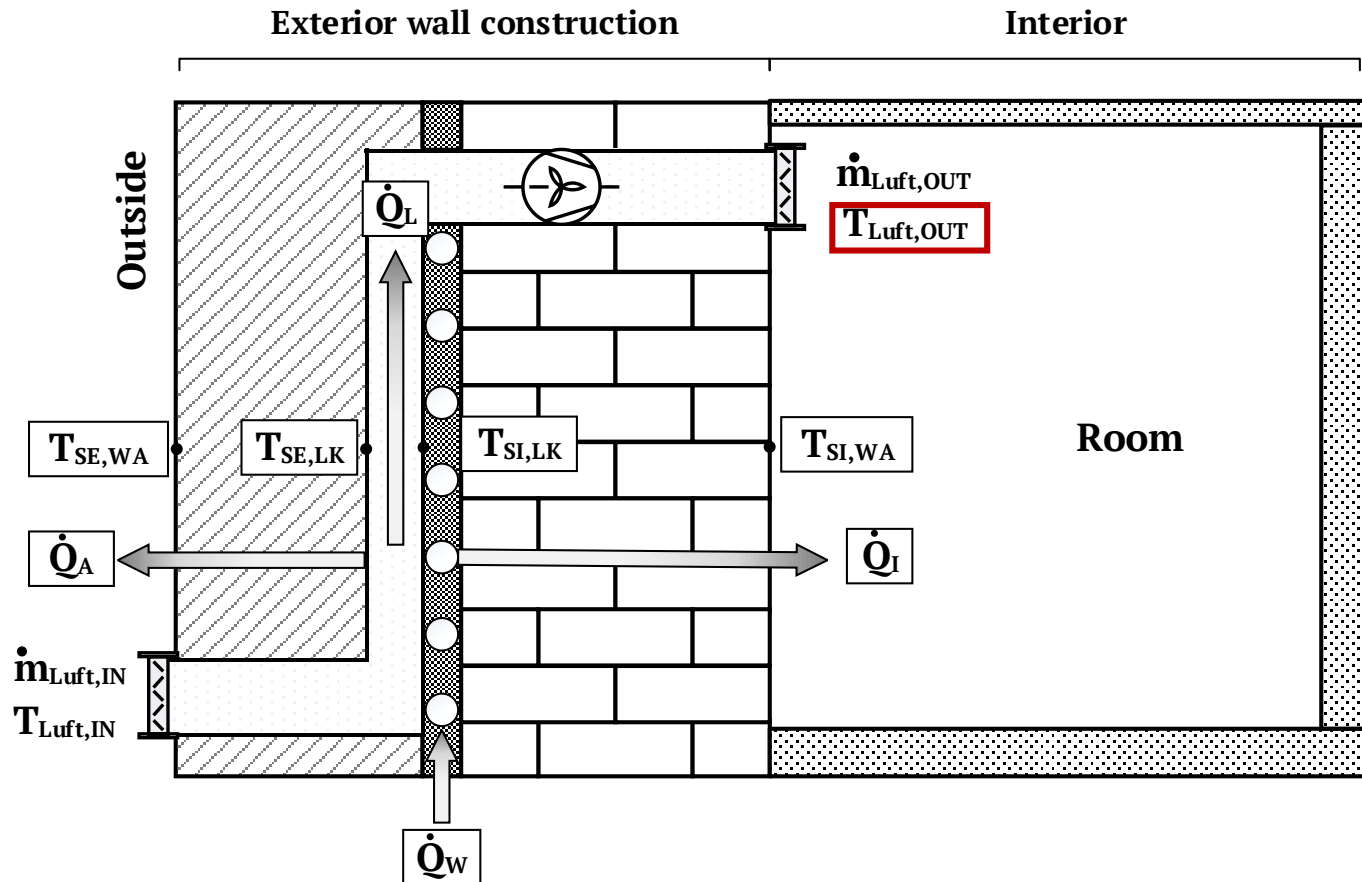
The slow adjustable aWT will be ideally or perfectly complemented by the quickly adjustable aLT.



→ Base Load + Peak Load possible.

LEXU II:

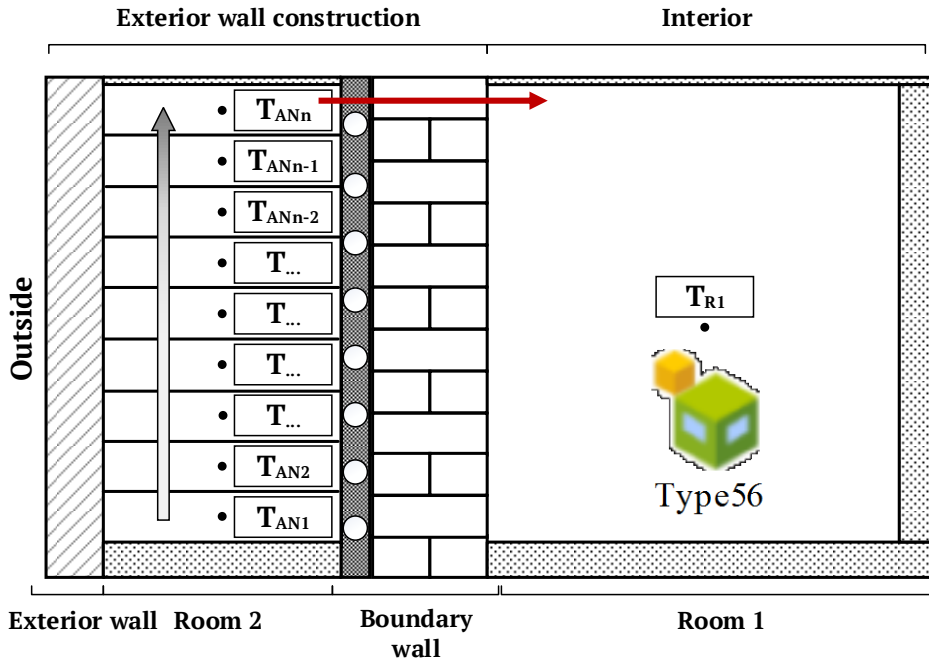
- Modeling of the aLT in TRNSYS
 - Energetic examination and further simulations (fluid dynamics simulation in ANSYS)



LEXU II:

Modeling of the aLT in TRNSYS: Two possibilities

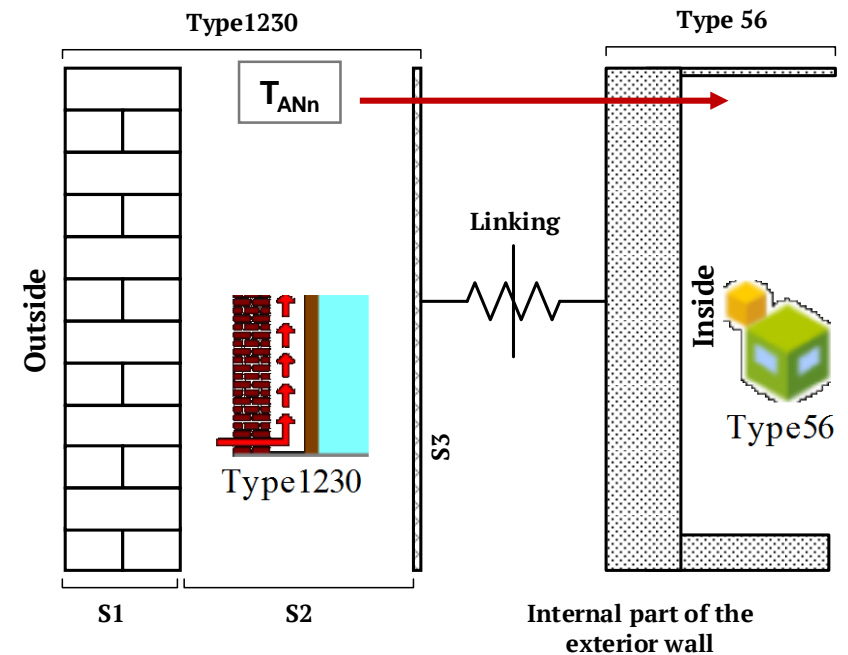
Multi-zone (airnode) approach in Type 56



Conclusion:

Similar simulation 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

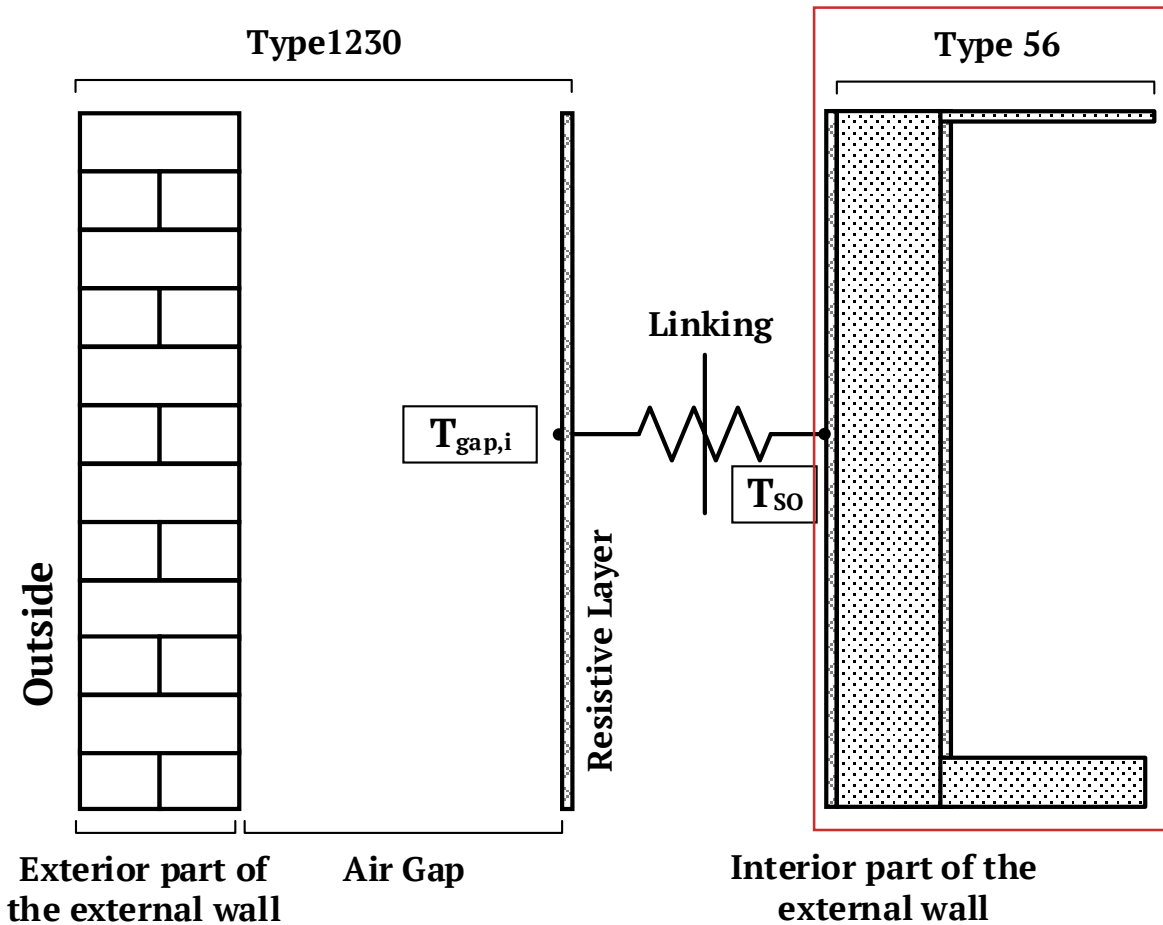
Type 1230: Ventilated Facade (TESS)



Conclusion:

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

Linking between Type 1230 und Type 56



TRNBuild: Zone XY / Airnode XY

Walls

Surf	Type	Area	Category
2	IWAND_L	1.00	INTERNAL
4	AUSSENWAND_1230	1.00	BOUNDARY

4 Surface-ID

wall type: AUSSENWAND_1230

area: 1 m²

category: **BOUNDARY**

geosurf: 0

surf. gain inside: 0 kJ/h

coupling air flow: 0 kg/h

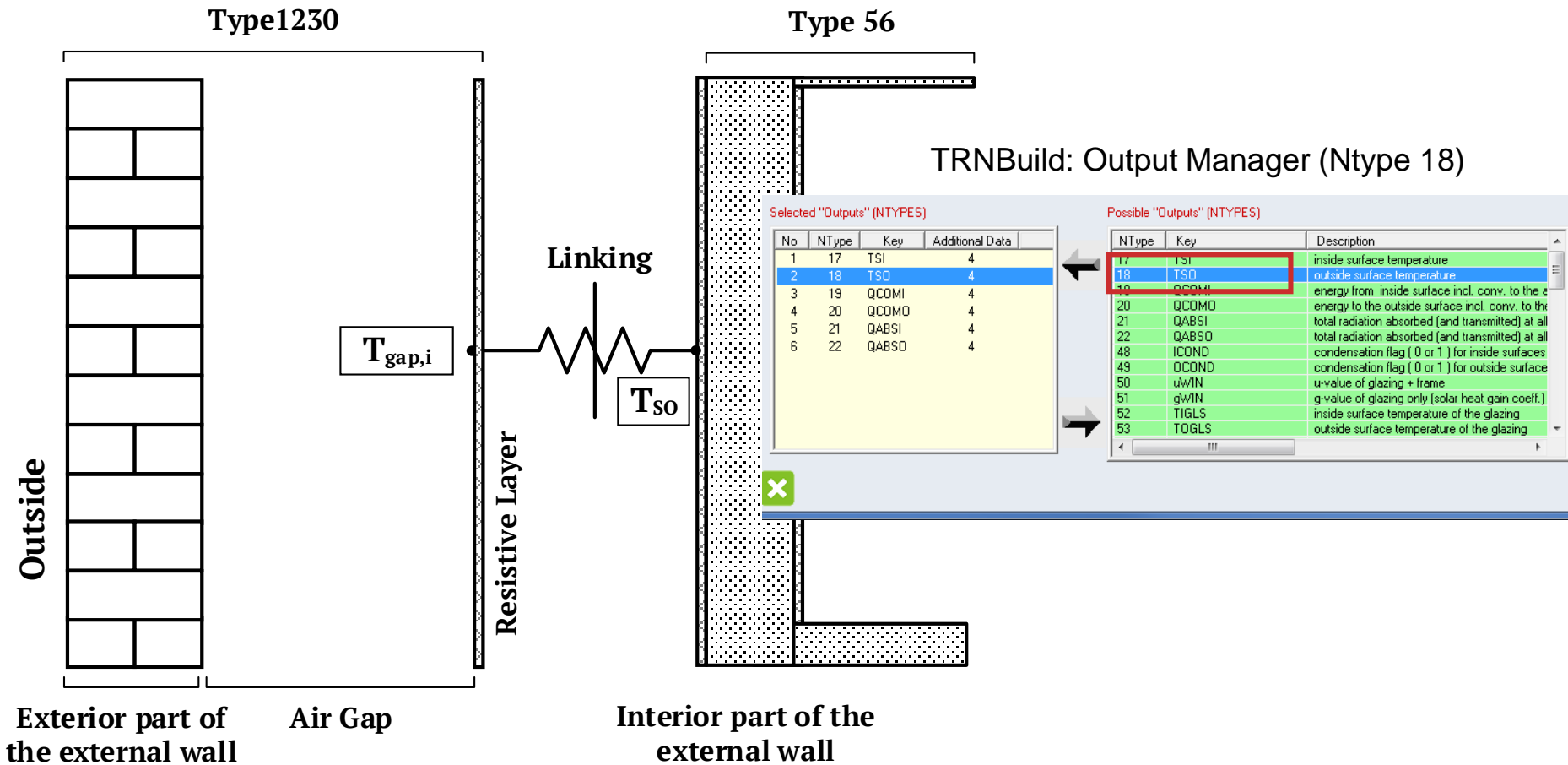
coupl. rel. humidity: 0 %

boundary conditions: userdefined identical

1: T_1230 °C

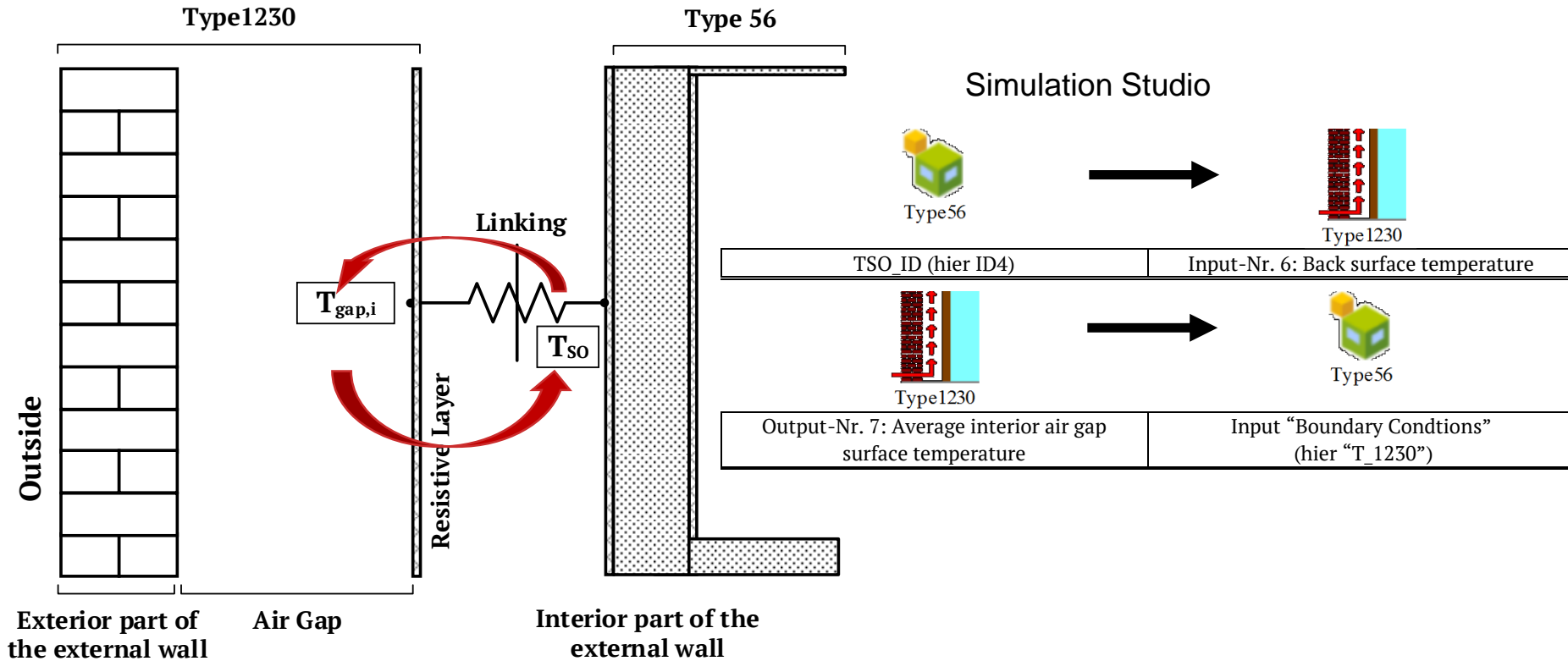
LEXU II:

Linking between Type 1230 und Type 56



LEXU II:

Linking between Type 1230 und Type 56



LEXU II:

Linking between Type 1230 und Type 56

TRNBuild: Wall Type Manager

Wall Type Manager

Wall Type: AUSSENWAND_1230

Layer

front / inside

No.	Layer	Thickness	Type
1	GIPSMOERTE	0.010	massive
2	VOLLKLINKE	0.200	massive
3	ZEMENTESTR	0.005	massive

back

total thickness: 0.215 m

u - value: 2.302 W/m²K for reference only
 (incl. alpha_i=7.7 W/m²K and alpha_o=25 W/m²K !)

Solar Absorptance of Wall

front: 0.6

back: 0.6

Longwave Emission Coefficient

front: 0.9

back: 0.9

Note:
 The emissivity of inside surfaces are applied by the detailed longwave radiation mode only!
 For the standard model fixed values of 0.9 are used.

Convective Heat Transfer Coefficient of Wall

front

back

userdefined internal calculation

11 kJ/h m²K

77.78 kJ/h m²K

Definition of the resistive layer

Type 1230: Parameter

Parameter	Input	Output	Derivative	Special Cards	External Files	Comment
6	Specific heat of wall material	0.9				kJ/kg.K
7	Conductivity of wall material	0.13				kJ/hr.m.K
8	Absorptance of exterior surface	0.6				-
9	Emissivity of exterior surface	0.9				-
10	Emissivity of inner surface	0.9				-
11	Emissivity of back surface	0.9				-
12	Resistance of back-side surface	0.01285				h.m2.K/KJ
13	Thickness of air gap	0.01				m

Inverse

LEXU II:

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

Type 1230: Output

(Laborwand_V001_SEG) Type1230

Parameter Input Output Derivative Special Cards External Files Comment

		Name	Value	Unit	More	Macro	Print
1		Air outlet temperature	10.0	C	More...	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2		Air flow rate	0	kg/hr	More...	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3		Exterior surface temperature	10.0	C	More...	<input checked="" type="checkbox"/>	<input type="checkbox"/>
4		Average wall temperature	10.0	C	More...	<input checked="" type="checkbox"/>	<input type="checkbox"/>
5		Average exterior air gap surface temperature	10.0	C	More...	<input checked="" type="checkbox"/>	<input type="checkbox"/>
6		Average air temperature	10.0	C	More...	<input checked="" type="checkbox"/>	<input type="checkbox"/>
7		Average interior air gap surface temperature	10.0	C	More...	<input checked="" type="checkbox"/>	<input type="checkbox"/>
8		Absorbed solar radiation	0	kWh	More...	<input type="checkbox"/>	<input type="checkbox"/>

TRNBuild: Ventilation Type Manager

New Ventilation Type

"Ventilation Type" Manager

new ventilation type: TYPE1230

AirFlow

air change rate

mass flow rate ▶ |: 1*M_ALT kg/h

Temperature of Air Flow

outside

other ▶ |: 1*T_OUT_1230 °C

Humidity of Air Flow

relative humidity

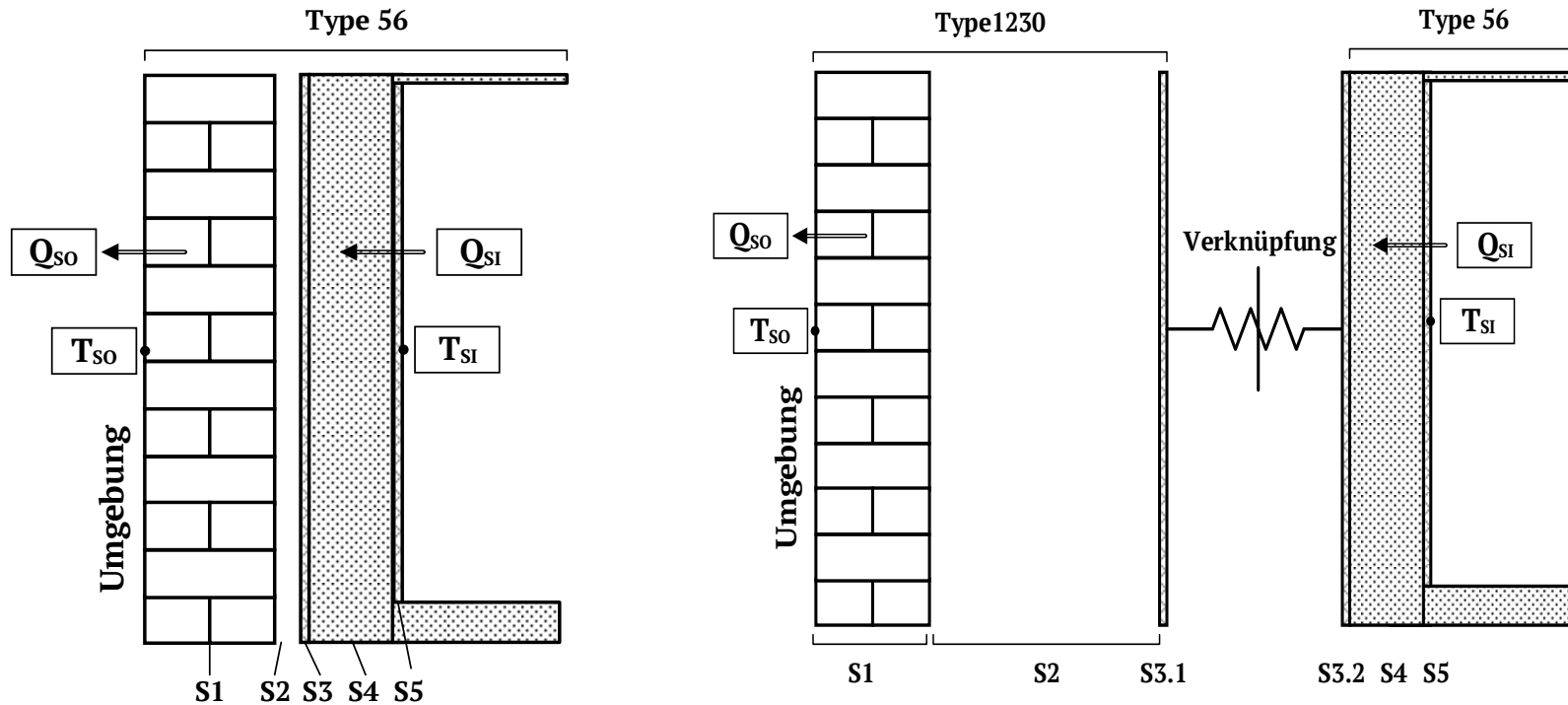
absolute humidity

outside

other ▶ |: 1*RH_1230_OUT %

Verification of Type 1230

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



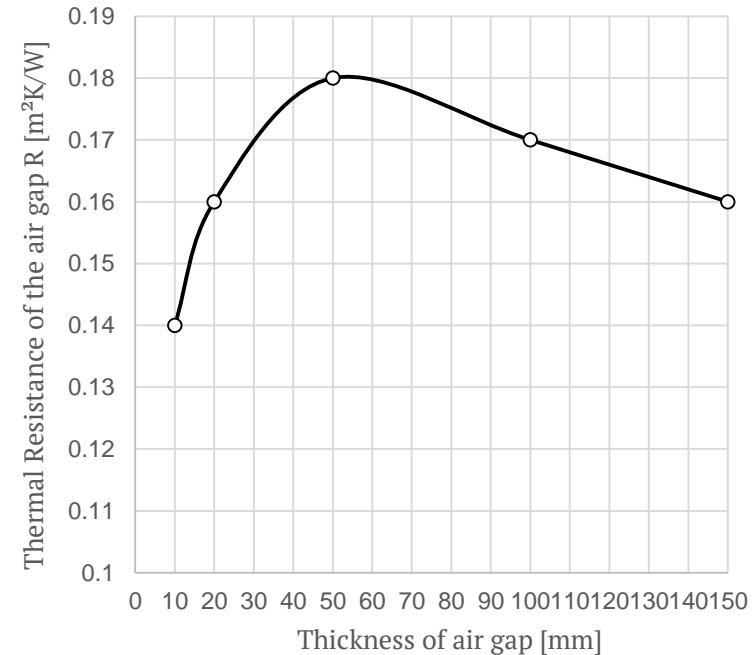
LEXU II:

Verification of Type 1230

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

Summary:

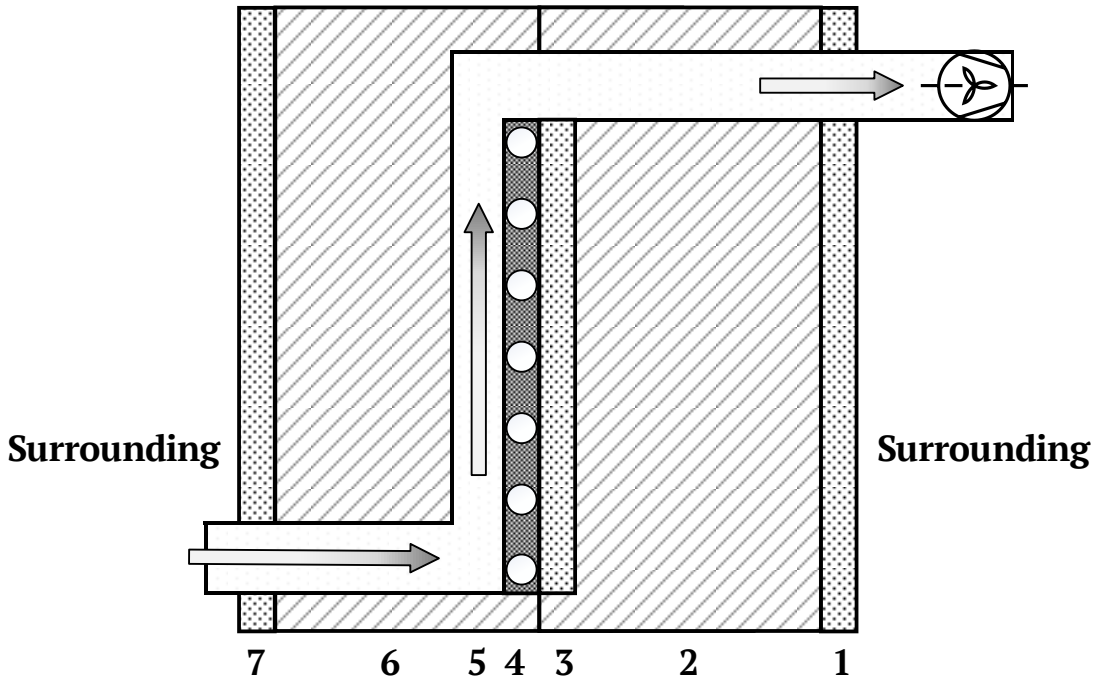
Differences <2% could be determined across all simulations and variations.



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

LEXU II:

Laboratory wall / test bench of the aLT

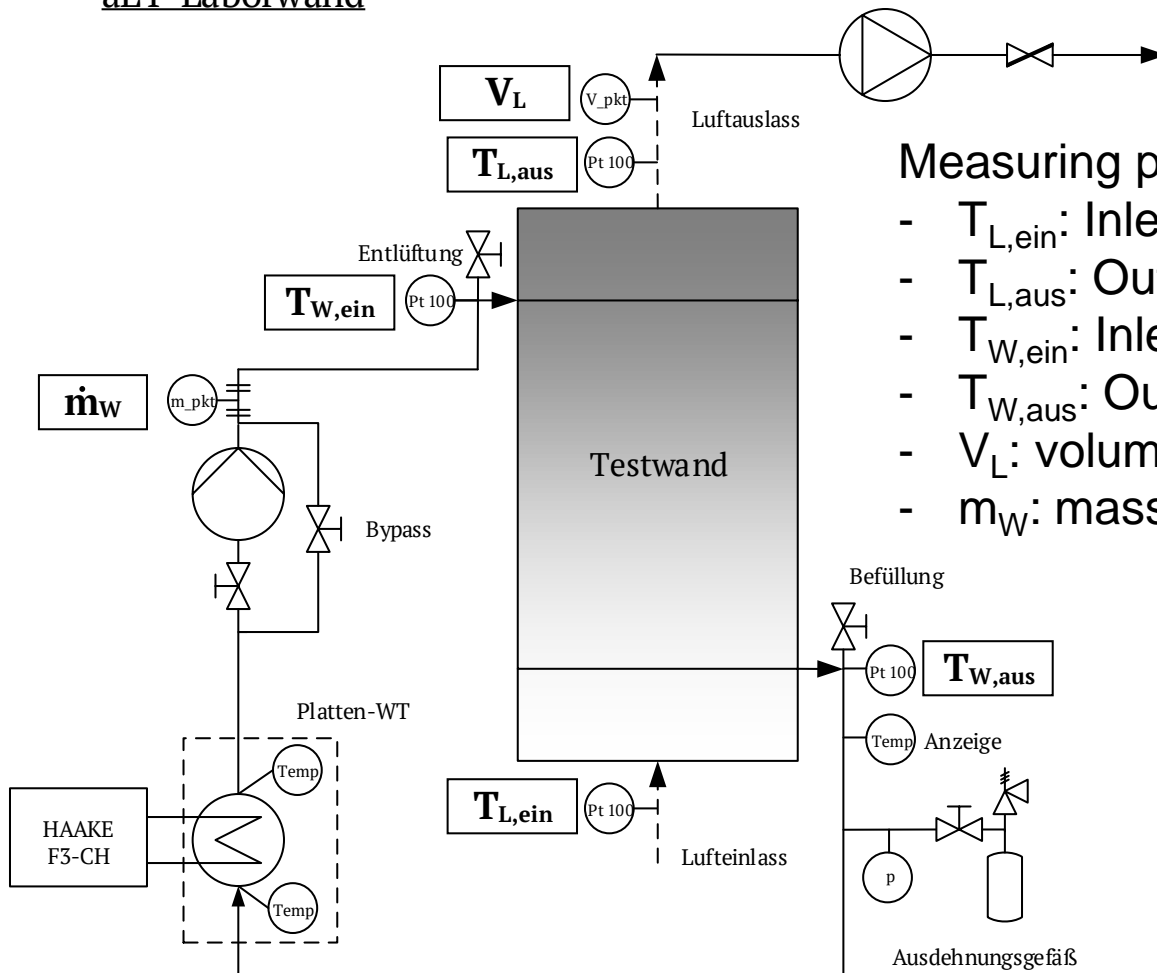


Nr.	Description	Thickness
1	Wood-fiberboard	18 mm
2	Insulation (Polystyrene)	160 mm
3	Wood-fiberboard	10 mm
4	Capillary tubes: active layer	10 mm
5	Air gap	20 mm
6	Insulation (Polystyrene)	160 mm
7	Wood-fiberboard	18 mm



Laboratory wall / test bench of the aLT

aLT-Laborwand



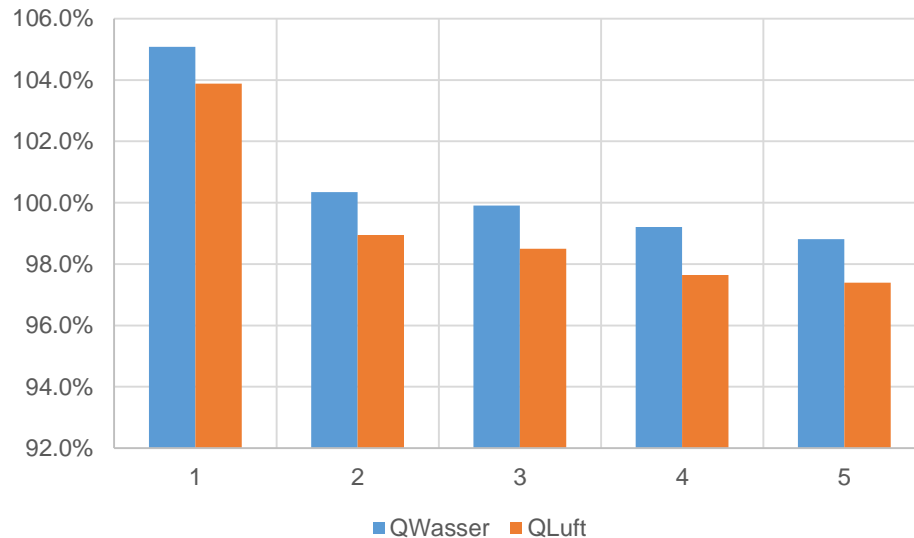
Measuring points:

- $T_{L,ein}$: 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:

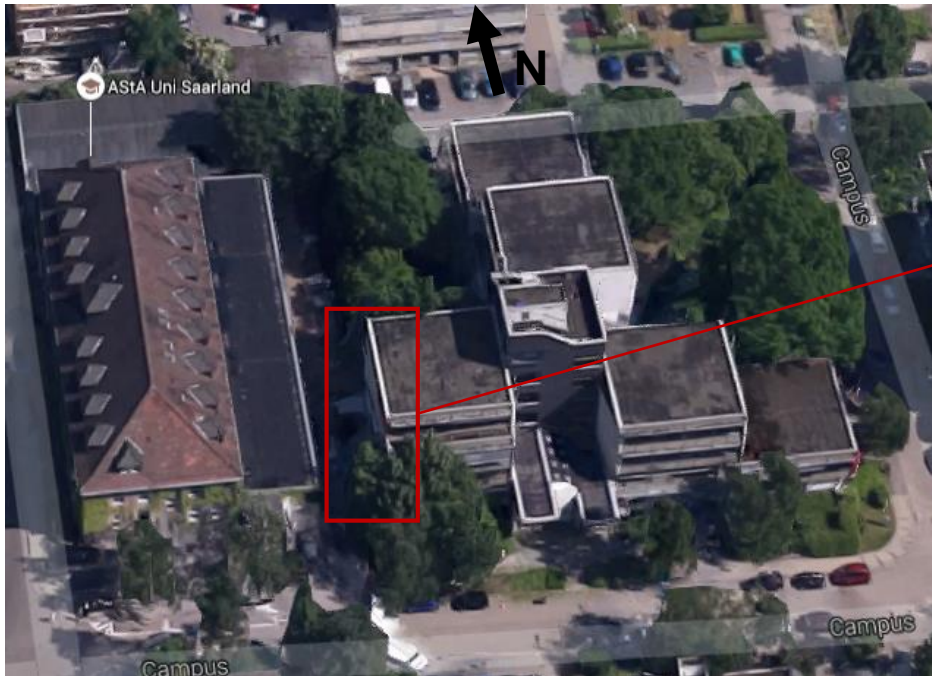
Good accordance of the measured data and the simulation results; differences ~5%

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

LEXU II: Demonstrator

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



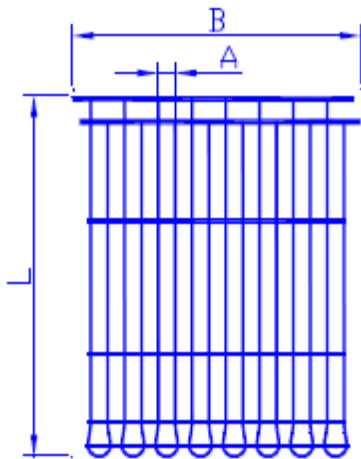
Quelle: Google Maps, 2017



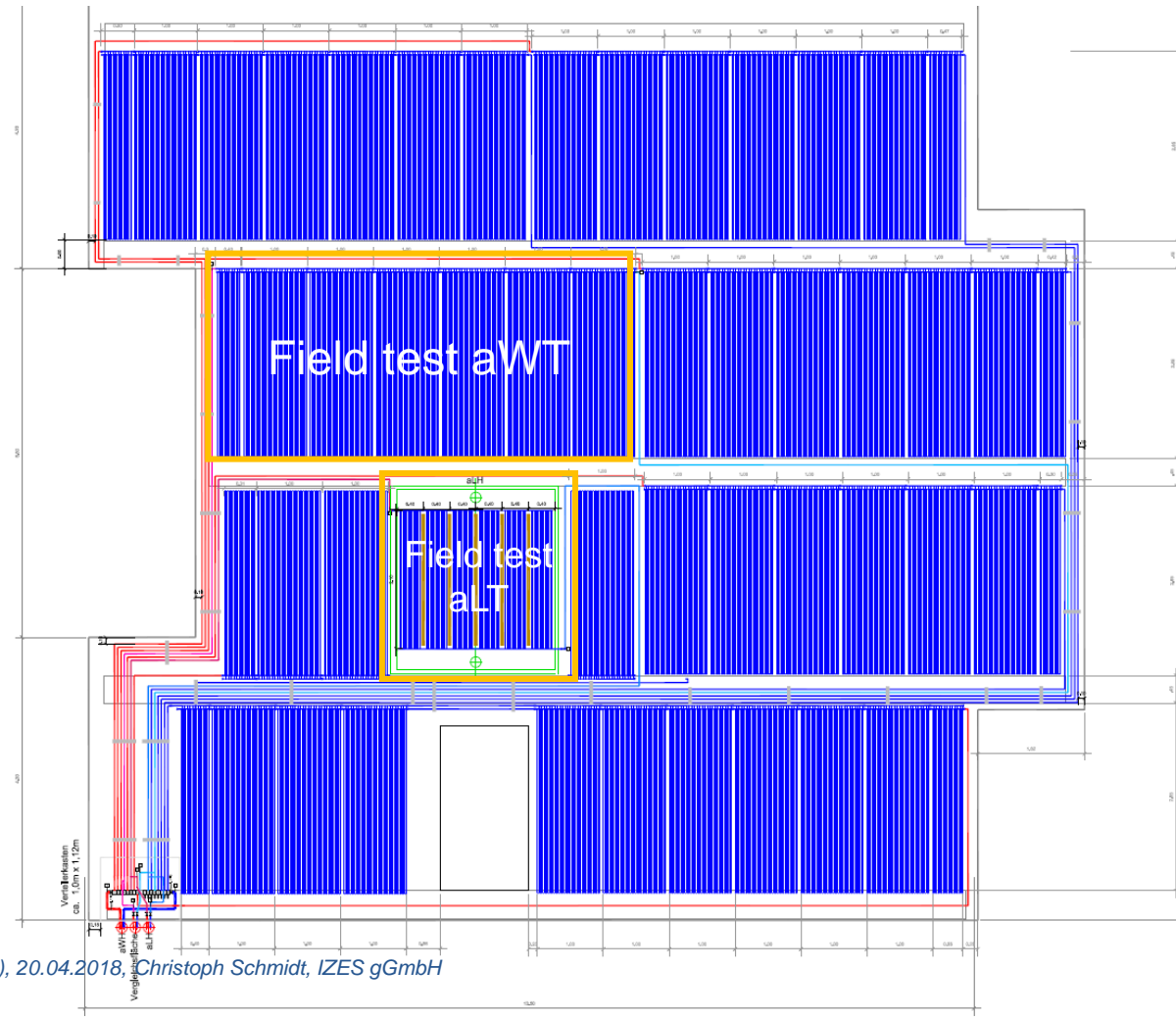
- Western frontage
 - Height: ~15 m
 - Width: ~13,5 m
 - Area: ~200 m²
 - 0,36 m ferroconcrete (Stahlbeton)

LEXU II: Demonstrator

- 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



LEXU II: Demonstrator

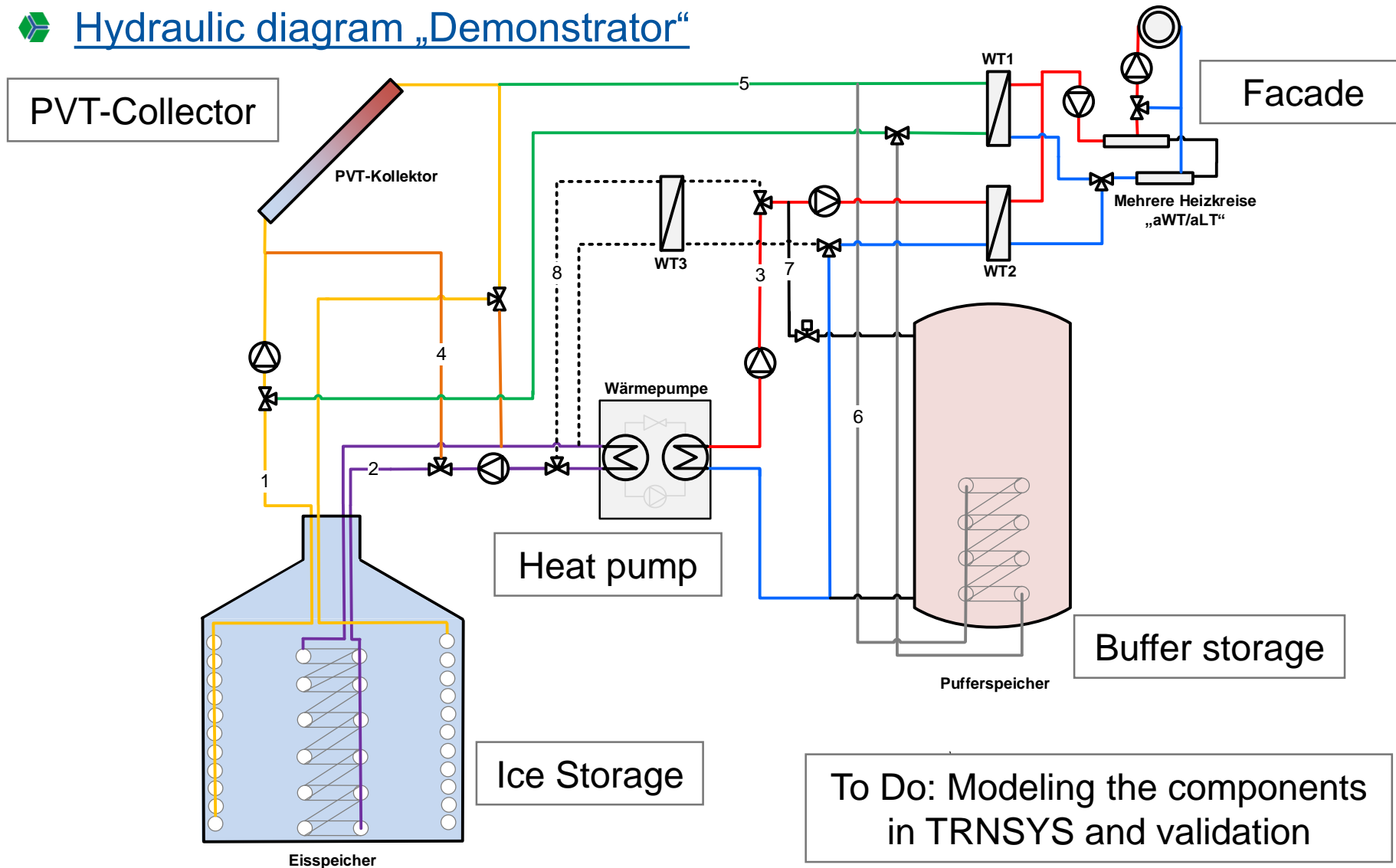
Realization



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

LEXU II: Demonstrator

Hydraulic diagram „Demonstrator“



To Do: Modeling the components in TRNSYS and validation

Questions?

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

Project management	Project partner	Supporter	Funding
 <p>izes gGmbH Institut für ZukunftsEnergie- und Stoffstromsysteme</p>  <p>SAARLAND Großes entsteht immer im Kleinen.</p>	 <p>Kapillarrohrtechnologie für Heiz- und Kühlsysteme</p>  <p>KOMPETENZZENTRUM AUSBAU UND FASSADE</p>  <p>VIESMANN</p>  <p>UNIVERSITÄT DES SAARLANDES Referat FM: Facility Management</p>  <p>GEFGA Energiesysteme GmbH</p> <p>WIDAG GbR Dr. Gerhard Luther</p>	    <p>HGE Ingenieur GmbH</p>	<p>Gefördert durch:</p>  <p>Bundesministerium für Wirtschaft und Energie</p>  <p>aufgrund eines Beschlusses des Deutschen Bundestages</p>