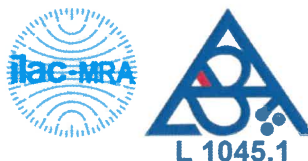




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Strojírenský zkušební ústav, s.p. Zkušební laboratoř
(Engineering Test Institute, Public Enterprise, Testing Laboratory)
Hudcova 424/56b, Medlánky, 621 00 Brno

Page 1 of 34



TEST REPORT

39-17652/T

Product: Outdoor Air/Water Heat pump

Type designation: Montivi-8kW

Customer: LARS Andrzej Szymański
ul. Świerkowa 14
64-320 Niepruszewo
POLAND

Manufacturer: LARS Andrzej Szymański
ul. Świerkowa 14
64-320 Niepruszewo
POLAND

Report issue date: 2024-08-21

Distribution list: 1 copy to the Customer
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SP-2021-000012_1_12

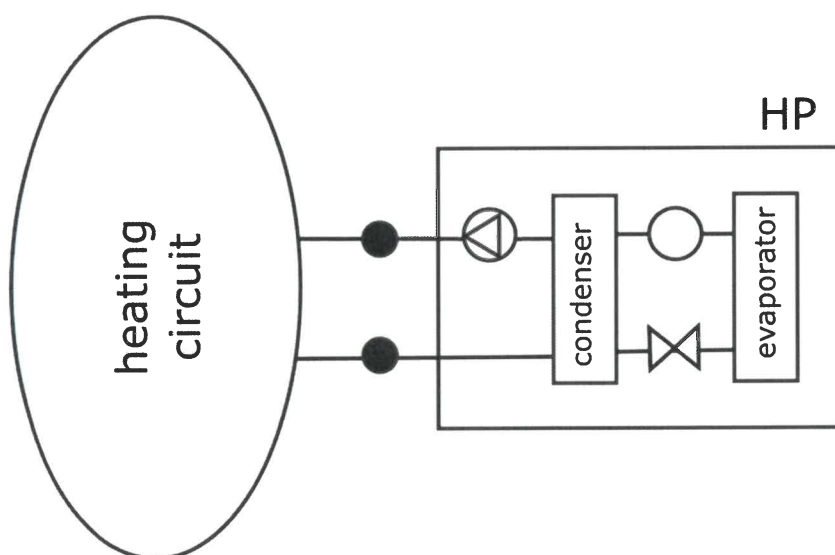
I. Description of product tested

The Heat pump **Montivi-8kW** supplied by the company **LARS Andrzej Szymański** is structurally adapted to operate in air/water system. Device is designed as monobloc placed outdoor and indoor display. Refrigerant R32 is used with charge 1.6 kg. Power supply is a three-phase. Heat pump is able to work in heating as well as cooling mode. Heat pump is working with variable flow rate.

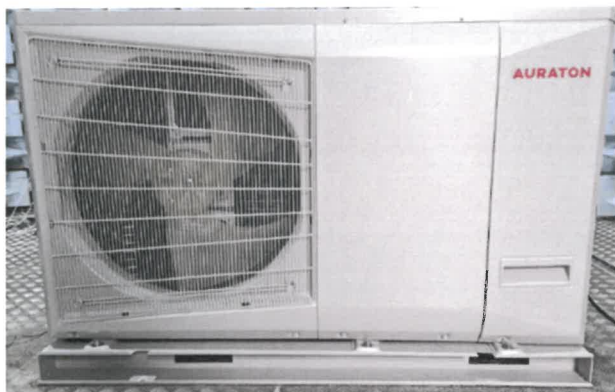
Main components of the outdoor unit **Montivi-8kW**:

- Serial number SFF0WDNBTU0026000211
- Cubic-shaped with dimensions 1350 × 400 × 880 mm (W × D × H)
- Frame and casing made of varnished steel sheets
- L-shaped evaporator, 2 rows, dimensions 1040 × 45 × 750 mm (W × D × H), spacing 1.6 mm
- Plate condenser, dimensions 135 × 120 × 360 mm (W × D × H) including insulation
- Compressor GMCC EKTF310D43UMT
- Refrigerant R32 (1.6 kg)
- Electric expansion valve Sanhua
- 4-way reversing valve Sanhua SHF-7H-35UP-P
- Refrigerant accumulator Dongguan Qingxin'an Refrigeration Fittings Co. Ltd, type 801601200044
- Axial fan ø50 cm Jiangmen LT Motor Co. Ltd
- Circulation pump Shimge APM25-9-130 PWM1
- Pressure sensors
- Temperature sensors
- Refrigerant pipes
- Air vent
- Remote display
- Software

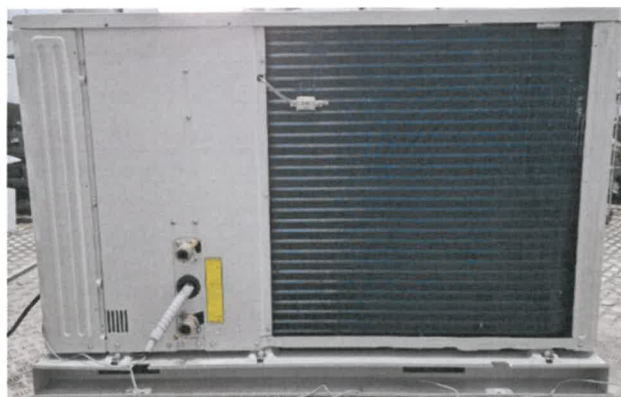
Scheme:



Photodocumentation:



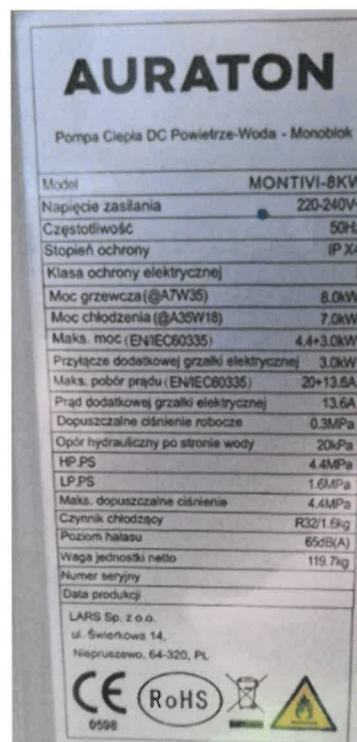
Heat pump **Montivi-8kW** – outdoor unit
– Front view –



Heat pump **Montivi-8kW** – outdoor unit
– Back view –



Heat pump **Montivi-8kW** – outdoor unit
– Compressor label –



Heat pump **Montivi-8kW** – outdoor unit
– Label –

II. Sample tested

SZU reg. no.	Product name	Date of submission
1212.24.39715.001	Montivi-8kW	2024-03-20

The visual inspection, tests and verification were carried out by Ing. Tomáš Sedláček at the test station of SZU. The tests were performed using measuring and testing equipment with valid calibration.

III. Measuring and test equipment:

No.	Description:	Inventory number:
1.	Electrical energy meter	E2.1
2.	Digital watt meter	1.2.2 ENERGIE ANALYZATOR_2
3.	Flow meter Krohne Optiflux	8.1.1 TECH_K1_V_DN15
4.	Barometer	2.4 MAR18_1_PB
5.	Differential pressure gauge	3.2 MAR18_2_dP
6.	Temperature-humidity meter HF532	3.1.1 K2_VLHKOST_1
7.	Temperature-humidity meter HF532	3.1.3 K2_VLHKOST_2
8.	Thermometers	3.4 MAR18_T

No.	Test objective	Requirement	Method of test	Documentation	Test evaluation/ verification *
1.	Rating conditions	-	ČSN EN 14511-2:2023 ČSN EN 14511-3:2023	Page No. 7	x
2.	Seasonal performance tests and SCOP calculation – Low temperature application	-	ČSN EN 14511-3:2023 ČSN EN 14825:2023	Page No. 8-14	x
3.	Seasonal performance tests and SCOP calculation – Medium temperature application	-	ČSN EN 14511-3:2023 ČSN EN 14825:2023	Page No. 15-21	x

*) **Evaluation / statement of conformity:**
+ Requirement fulfilled 0 Not applicable
- Requirement not fulfilled x Not evaluated

Measured quantity	Unit	Uncertainty measurement of	Evaluation
Liquid			
- temperature difference (dT)	[K]	$\pm 0.15 \text{ K}$	fulfilled
- temperature inlet/outlet	[°C]	$\pm 0.15 \text{ K}$	fulfilled
- volume flow	[m ³ /s]	$\pm 1 \%$	fulfilled
- static pressure difference	[kPa]	$\pm 1 \text{ kPa}$ ($\Delta p \leq 20 \text{ kPa}$) or $\pm 5 \%$ ($\Delta p > 20 \text{ kPa}$)	fulfilled
Air			
- dry bulb temperature	[°C]	$\pm 0.2 \text{ K}$	fulfilled
- wet bulb temperature	[°C]	$\pm 0.4 \text{ K}$	fulfilled
- volume flow	[m ³ /s]	$\pm 5 \%$	not applied
- static pressure difference	[Pa]	$\pm 5 \text{ Pa}$ ($\Delta p \leq 100 \text{ Pa}$) or $\pm 5 \%$ ($\Delta p > 100 \text{ Pa}$)	not applied
Refrigerant			
- pressure at compressor outlet	[kPa]	$\pm 1 \%$	not applied
- temperature	[°C]	$\pm 0.5 \text{ K}$	not applied
Concentration (in volume)			
- heat transfer medium	[%]	± 2	not related
Electrical quantities			
- electric power	[W]	$\pm 1 \%$	fulfilled
- voltage	[V]	$\pm 0.5 \%$	fulfilled
- current	[A]	$\pm 0.5 \%$	fulfilled
- electric energy	[kWh]	$\pm 1 \%$	not applied
Compressor rotational speed	[min ⁻¹]	$\pm 0.5 \%$	not applied
The heating or cooling capacities measured on the liquid side shall be determined within a maximum uncertainty of 5 % independent of the individual uncertainties of measurement including the uncertainties on the properties of fluids.			fulfilled

Note:

The stated extended measurement uncertainties are calculated as a factor of the measurement uncertainty and the extension coefficient $k=2$, corresponding to the coverage certainty of 95% as regards standard classification.

If a statement of conformity is provided, the decision rule pursuant to ILAC-G8:09/2019, Art. 4.2.1 - binary statement for the simple acceptance rule shall apply.

Comment to abbreviated marking: e.g. A7/W35

A (air) 7 (input air, dry-bulb temperature in °C) / W (water), 35 (output heating water temperature in °C)

Test objective:	Rating conditions
Exact name of the test procedure:	1.37* - Tests of leakage, pressure resistance, thermal and technical parameters, combustion efficiency, safety functions
Test method:	ČSN EN 14511-2:2023, ČSN EN 14511-3:2023
Sample tested:	Heat pump Montivi-8kW
Measuring equipment used:	see Chapter III

Specification of the assessment condition		A7/W35	A7/W55
Date of testing		2024-07-19	2024-07-19
Transient test procedure	YES / NO	NO	NO
Average defrost time of 1 cycle	[min]	–	–
Average time of 1 cycle	[min]	–	–
Calculation time	[min]	70.0	70.0
Output heating water – temperature calculation	[°C]	34.96	54.97
Input heating water – temperature calculation	[°C]	29.95	46.97
Output heating water temperature	[°C]	34.96	54.97
Input heating water temperature	[°C]	29.95	46.97
Air temperature – dry bulb temperature	[°C]	7.00	7.00
Air temperature – wet bulb temperature	[°C]	6.01	6.00
Relative humidity	[%]	87.01	86.83
Barometric pressure	[kPa]	99.000	98.926
Ambient temperature	[°C]	6.97	7.01
Secondary circuit pressure difference	[kPa]	2.369	9.719
Efficiency of the secondary liquid pump	[-]	0.125	0.143
Volume flow rate of heating water	[m ³ ·h ⁻¹]	1.4701	0.8807
Density of heating water	[kg·m ⁻³]	994.1	986.0
Specific heat capacity of heating water	[kJ·kg ⁻¹ ·K ⁻¹]	4.175	4.179
Voltage	[V]	232.55	402.29
Total current	[A]	8.21	12.02
Overall power input	[kW]	1.680	2.661
Capacity correction of sec. liquid pump	[W]	6.794	14.269
Power input correction of sec. liquid pump	[W]	7.76	16.65
Heating capacity – heating water	[kW]	8.490	8.096
Corrected heating capacity – heating water	[kW]	8.483	8.082
Uncertainty of corrected heating capacity	[kW]	± 0.146	± 0.089
Effective electric power input	[kW]	1.673	2.645
COP	[-]	5.072	3.056
Uncertainty of COP	[-]	± 0.088	± 0.034
Control settings	[Hz]	44	46
Circulation pump settings – heating water	[%]	40	40
Fan settings	[rpm]	780	780

Test objective:	Seasonal performance tests and SCOP calculation – Low temperature application
Exact name of the test procedure:	1.37* - Tests of leakage, pressure resistance, thermal and technical parameters, combustion efficiency, safety functions
Test method:	ČSN EN 14511-3:2023, ČSN EN 14825:2023
Sample tested:	Heat pump Montivi-8kW
Measuring equipment used:	see Chapter III

Design		Air / water – monobloc						
Conditions specification according to ČSN 14825:2023	to EN	Temperature application			Low (reference water temperature 35 °C)			
		Reference heating season			Average			
		Outlet water temperature - indoor heat exchanger			Variable			
		Compressor speed control			Variable			
		Water flow rate – primary circuit			–			
		Water flow rate – secondary circuit			Variable			
Seasonal heating efficiency	space energy	Heating	Average	η_s		208.0	%	
			Warmer	η_s		–	%	
			Colder	η_s		–	%	
Seasonal efficiency according to ČSN 14825:2023	EN	Heating	Average	SCOP		5.27	–	
			Warmer	SCOP		–	–	
			Colder	SCOP		–	–	
Function	Cooling					Yes		
	Heating	Yes	Reference heating season	Average		Yes		
				Warmer		–		
				Colder		–		
Full heating load	Cooling		P _{designc}		–		kW	
	Heating	Average	P _{designh}		8.30		kW	
		Warmer	P _{designh}		–		kW	
		Colder	P _{designh}		–		kW	
Bivalent temperatures	Heating	Average	T _{bivalent}		-7		°C	
		Warmer	T _{bivalent}		–		°C	
		Colder	T _{bivalent}		–		°C	
Operation temperatures	limit	Heating	Average	TOL		-10		°C
			Warmer	TOL		–		°C
			Colder	TOL		–		°C
Seasonal consumption according to ČSN EN 14825:2023	power to	Cooling		Q _{CE}		–		kWh
		Heating	Average	Q _{HE}		3250		kWh
			Warmer	Q _{HE}		–		kWh
			Colder	Q _{HE}		–		kWh
Modes other than „active mode“			Off mode		P _{OFF}	6.3	W	
			Thermostat off mode		P _{TO}	5.2	W	
			Standby mode		P _{SB}	6.3	W	
			Crankcase heater mode		P _{CK}	0.0	W	

Calculation of SCOP according to ČSN EN 14825:2023:

Number of hours used for calculation of reference SCOP (Annex B – Table B. 2, B. 3)

- For reversible heat pumps and reference heating season „A“ = average

H _{HE}	2066	[h]
H _{TO}	178	[h]
H _{SB}	0	[h]
H _{CK}	178	[h]
H _{OFF}	0	[h]

Measured data:

P _{TO}	0.0052	[kW]
P _{SB}	0.0063	[kW]
P _{CK}	0.0000	[kW]
P _{OFF}	0.0063	[kW]
P _{designh}	8.30	[kW]
SCOP _{ON}	5.28	[-]

Coefficient and correction:

F(1)	3	[%]
F(2)	0	[%]
CC	2.5	[-]

Calculation of SCOP:

7.3 Calculation of the reference annual heating demand (Q_H)

$$Q_H = P_{\text{designh}} \cdot H_{HE} \quad [\text{kWh}]$$

$$Q_H = 8.3 \cdot 2066 = 17142 \quad [\text{kWh}]$$

7.4 Calculation of the annual electricity consumption (Q_{HE})

$$Q_{HE} = Q_H / \text{SCOP}_{\text{on}} + H_{TO} \cdot P_{TO} + H_{SB} \cdot P_{SB} + H_{CK} \cdot P_{CK} + H_{OFF} \cdot P_{OFF} \quad [\text{kWh}]$$

$$Q_{HE} = 17142 / 5.28 + 178 \cdot 0.0052 + 0 \cdot 0.0063 + 178 \cdot 0 + 0 \cdot 0.0063 = 3250 \quad [\text{kWh}]$$

7.2 General formula for calculation of reference SCOP

$$\text{SCOP} = Q_H / Q_{HE} \quad [-]$$

$$\text{SCOP} = 17142 / 3250 = 5.27 \quad [-]$$

7.1 Calculation of the seasonal space heating efficiency η_s

$$\Sigma F(i) = F(1) + F(2) \quad [-]$$

$$\Sigma F = 0.03 + 0 = 0.03 \quad [-]$$

$$\eta_s = 1 / \text{CC} \cdot \text{SCOP} - \Sigma F(i) \quad [-]$$

$$\eta_s / A = (1 / 2.5) \cdot 5.27 - 0.03 = \underline{\underline{2.08}} \quad [-]$$

Temperature level		Low (reference water temperature 35 °C)		
Reference heating season		„A“ = average ($T_{\text{designh}} = -10\text{ °C}$)		
Assessment condition		A, T _{biv} (F)	B	C
Specification of the assessment condition		A-7/W34	A2/W30	A7/W27
Date of testing		2024-07-18	2024-07-22	2024-07-24
Transient test procedure	YES / NO	NO	NO	NO
Average defrost time of 1 cycle	[min]	–	–	–
Average time of 1 cycle	[min]	–	–	–
Calculation time	[min]	70.0	70.0	70.0
Output heating water – temperature calculation	[°C]	34.00	30.00	27.08
Input heating water – temperature calculation	[°C]	29.01	25.00	22.08
Output heating water temperature	[°C]	34.00	30.00	27.08
Input heating water temperature	[°C]	29.01	25.00	22.08
Air temperature – dry bulb temperature	[°C]	-6.99	1.99	7.00
Air temperature – wet bulb temperature	[°C]	-7.98	1.18	6.01
Relative humidity	[%]	75.07	86.94	86.98
Barometric pressure	[kPa]	99.086	98.155	98.349
Ambient temperature	[°C]	-7.01	1.96	6.92
Secondary circuit pressure difference	[kPa]	15.877	10.804	12.332
Efficiency of the secondary liquid pump	[-]	0.184	0.141	0.133
Volume flow rate of heating water	[m ³ ·h ⁻¹]	1.2800	0.7324	0.4757
Density of heating water	[kg·m ⁻³]	994.4	995.6	996.4
Specific heat capacity of heating water	[kJ·kg ⁻¹ ·K ⁻¹]	4.175	4.176	4.177
Voltage	[V]	231.89	231.71	231.87
Total current	[A]	10.15	4.96	2.65
Overall power input	[kW]	2.229	0.858	0.392
Capacity correction of sec. liquid pump	[W]	25.041	13.444	10.606
Power input correction of sec. liquid pump	[W]	30.68	15.64	12.24
Heating capacity – heating water	[kW]	7.365	4.212	2.740
Corrected heating capacity – heating water	[kW]	7.340	4.198	2.730
Uncertainty of corrected heating capacity	[kW]	± 0.127	± 0.073	± 0.047
Effective electric power input	[kW]	2.199	0.842	0.380
COP	[-]	3.338	4.983	7.188
Uncertainty of COP	[-]	± 0.058	± 0.087	± 0.126
Control settings	[Hz]	59	25	14
Circulation pump settings – heating water	[%]	40	40	40
Fan settings	[rpm]	860	730	330

Temperature level		Low (reference water temperature 35 °C)	
Reference heating season		„A“ = average ($T_{designh} = -10\text{ °C}$)	
Assessment condition		D	TOL (E)
Specification of the assessment condition		A12/W26.96	A-10/W35
Date of testing		2024-07-19	2024-07-18
Transient test procedure	YES / NO	NO	NO
Average defrost time of 1 cycle	[min]	–	–
Average time of 1 cycle	[min]	–	–
Calculation time	[min]	70.0	70.0
Output heating water – temperature calculation	[°C]	26.91	35.03
Input heating water – temperature calculation	[°C]	21.91	30.00
Output heating water temperature	[°C]	26.91	35.03
Input heating water temperature	[°C]	21.91	30.00
Air temperature – dry bulb temperature	[°C]	12.00	-9.99
Air temperature – wet bulb temperature	[°C]	11.00	-11.03
Relative humidity	[%]	89.02	68.70
Barometric pressure	[kPa]	98.595	99.036
Ambient temperature	[°C]	11.89	-9.99
Secondary circuit pressure difference	[kPa]	12.051	40.179
Efficiency of the secondary liquid pump	[-]	0.136	0.277
Volume flow rate of heating water	[m ³ ·h ⁻¹]	0.5458	1.4226
Density of heating water	[kg·m ⁻³]	996.4	994.0
Specific heat capacity of heating water	[kJ·kg ⁻¹ ·K ⁻¹]	4.177	4.175
Voltage	[V]	233.12	401.50
Total current	[A]	2.38	13.43
Overall power input	[kW]	0.355	3.079
Capacity correction of sec. liquid pump	[W]	11.635	41.541
Power input correction of sec. liquid pump	[W]	13.46	57.42
Heating capacity – heating water	[kW]	3.145	8.230
Corrected heating capacity – heating water	[kW]	3.133	8.188
Uncertainty of corrected heating capacity	[kW]	± 0.054	± 0.142
Effective electric power input	[kW]	0.341	3.022
COP	[-]	9.185	2.710
Uncertainty of COP	[-]	± 0.162	± 0.047
Control settings	[Hz]	14	74
Circulation pump settings – heating water	[%]	40	40
Fan settings	[rpm]	250	860

Data for SCOP calculation

- Low temperature application (reference water temperature 35 °C)
- Reference heating season „A“ – average

	Outdoor heat exchanger	Indoor heat exchanger	Part load ratio	Part load	DC Declared capacity	COPd at declared capacity	Cdh degradation coefficient	CR	COPbin (Tj)	Eff. power input of compressor off state
	Outdoor air inlet	Outlet water temperature								
	[°C]	[°C]	[%]	[kW]	[kW]	[-]	[-]	[-]	[-]	[kW]
A	-7	34.00	88.46	7.34	7.340	3.338	0.900	1.00	3.338	–
B	2	30.00	53.85	4.47	4.198	4.983	0.900	1.00	4.983	–
C	7	27.00	34.62	2.87	2.730	7.118	0.900	1.00	7.118	–
D	12	26.96	15.38	1.28	3.133	9.185	0.985	0.41	8.986	0.0052
TOL (E)	-10	35.00	100.00	8.30	8.188	2.710	0.900	1.00	2.710	–
Tbiv (F)	-7	34.00	88.46	7.34	7.340	3.338	0.900	1.00	3.338	–

Adaption of water temperature – according to ČSN EN 14825:2023, Annex E

- Low temperature application (reference water temperature 35 °C)
- Reference season „A“ – average
- Condition D
- Variable water flow rate – secondary circuit

General formulas and derivation:

$$\begin{aligned}
 t_{\text{outlet, average}} &= t_{\text{inlet, capacity test}} + (t_{\text{outlet, capacity test}} - t_{\text{inlet, capacity test}}) \cdot CR & [\text{°C}] \\
 t_{\text{outlet, average}} &= t_{\text{inlet, capacity test}} + (\Delta t) \cdot CR & [\text{°C}] \\
 t_{\text{outlet, average}} &= t_{\text{outlet, capacity test}} - \Delta t + \Delta t \cdot CR & [\text{°C}] \\
 t_{\text{outlet, capacity test}} &= t_{\text{outlet, average}} + \Delta t - \Delta t \cdot CR & [\text{°C}]
 \end{aligned}$$

For variable flow:

$$\Delta t = 5$$

$$CR \cdot \Delta t = \text{Part load} / \text{Declared capacity} \cdot 5$$

$$t_{\text{outlet, capacity test, variable flow}} = t_{\text{outlet, average}} + 5 - \text{Part load} / \text{Declared capacity} \cdot 5$$

Measured data:

$t_{\text{outlet, average}}$	24.00	[°C]
Declared capacity	3.133	[kW]
Declared capacity standard rating condition A7/W35	-	[kW]
Part load	1.28	[kW]

Calculation of water temperature

$$t_{\text{outlet, capacity test, variable flow}} = 24 + 5 - 1.28 / 3.133 \cdot 5 = \underline{\underline{26.96}} \quad [\text{°C}]$$

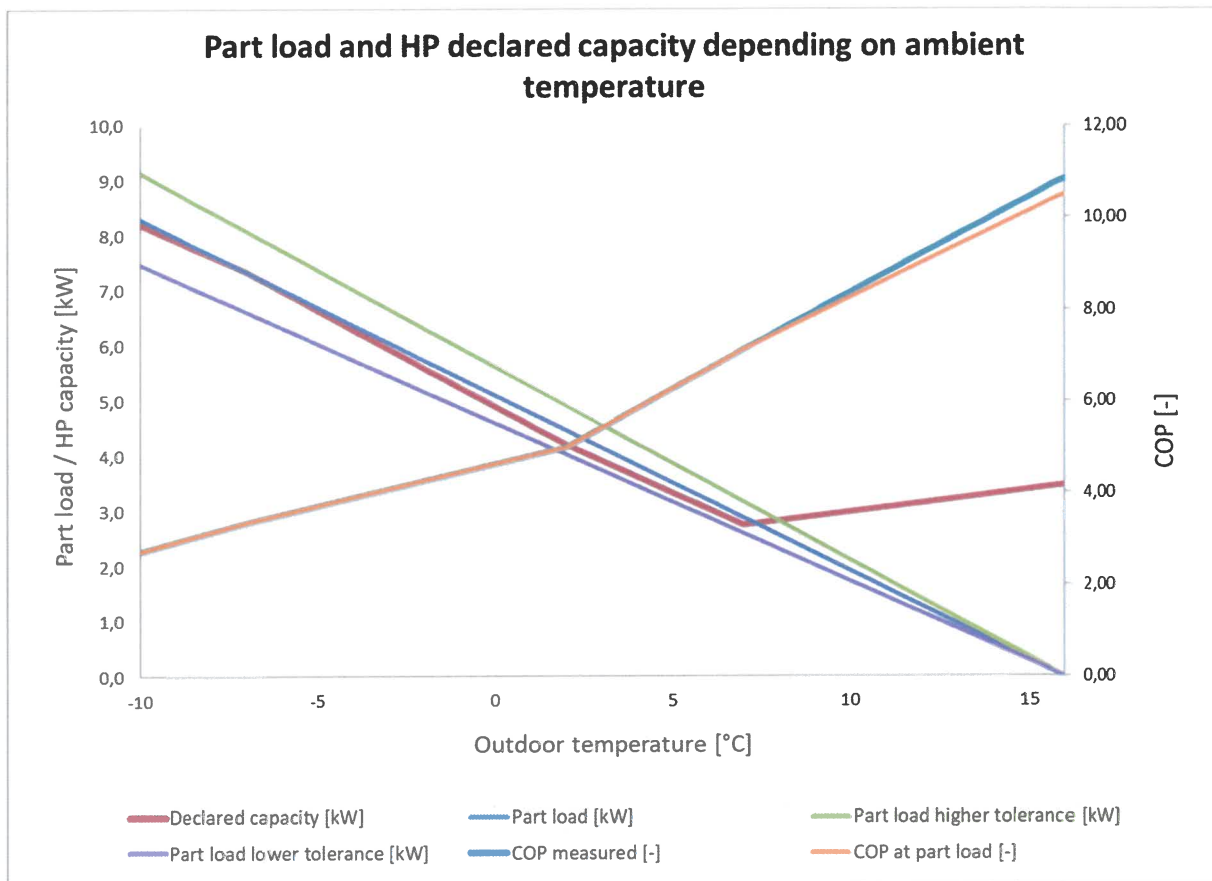
Calculation SCOP, SCOP_{on}, SCOP_{net}

- Low temperature application (reference water temperature 35 °C)
- Reference heating season „A“ – average

	Bin	Outdoor temp. (dry bulb)	Hours	Part load ratio	Heat load	Capacity of HP	Heat load covered by heat pump	Resistive heat elbu (Tj)	Annual resistive heat	COPbin (Tj)	Annual heating demand	Annual power input including electric back up heating	Net annual heating capacity	Net annual power input without electric back up heating
	j	Tj	hj		Ph(Tj)			elbu(Tj)	hj x elbu(Tj)	COPb in (Tj)	hj x P h(Tj)		hj x (P h(Tj) - elbu(Tj))	
	[-]	[°C]	[h]	[%]	[kW]	[kW]	[kW]	[kW]	[kWh]	[-]	[kWh]	[kWh]	[kWh]	[kWh]
TOL (E)	21	-10	1	100.00	8.30	8.19	8.19	0.11	0.11	2.71	8	3	8	3
	22	-9	25	96.15	7.98	7.91	7.91	0.07	1.82	2.92	199	70	198	68
	23	-8	23	92.31	7.66	7.62	7.62	0.04	0.84	3.13	176	57	175	56
A, Tblv (F)	24	-7	24	88.46	7.34	7.34	7.34	0.00	0.00	3.34	176	53	176	53
	25	-6	27	84.62	7.02	6.99	6.99	0.00	0.00	3.52	190	54	190	54
	26	-5	68	80.77	6.70	6.64	6.64	0.00	0.00	3.70	456	123	456	123
	27	-4	91	76.92	6.38	6.29	6.29	0.00	0.00	3.89	581	149	581	149
	28	-3	89	73.08	6.06	5.94	5.94	0.00	0.00	4.07	540	133	540	133
	29	-2	165	69.23	5.74	5.59	5.59	0.00	0.00	4.25	948	223	948	223
	30	-1	173	65.38	5.43	5.25	5.25	0.00	0.00	4.43	939	212	939	212
	31	0	240	61.54	5.11	4.90	4.90	0.00	0.00	4.62	1225	265	1225	265
	32	1	280	57.69	4.79	4.55	4.55	0.00	0.00	4.80	1340	279	1340	279
B	33	2	320	53.85	4.47	4.20	4.20	0.00	0.00	4.98	1430	287	1430	287
	34	3	357	50.00	4.15	3.90	3.90	0.00	0.00	5.41	1481	274	1481	274
	35	4	356	46.15	3.83	3.61	3.61	0.00	0.00	5.84	1363	234	1363	234
	36	5	303	42.31	3.51	3.32	3.32	0.00	0.00	6.26	1064	170	1064	170
	37	6	330	38.46	3.19	3.02	3.02	0.00	0.00	6.69	1053	157	1053	157
C	38	7	326	34.62	2.87	2.73	2.73	0.00	0.00	7.12	936	132	936	132
	39	8	348	30.77	2.55	2.81	2.55	0.00	0.00	7.49	888	119	888	119
	40	9	335	26.92	2.23	2.89	2.23	0.00	0.00	7.87	748	95	748	95
	41	10	315	23.08	1.91	2.97	1.91	0.00	0.00	8.24	603	73	603	73
	42	11	215	19.23	1.60	3.05	1.60	0.00	0.00	8.61	343	40	343	40
D	43	12	169	15.38	1.28	3.13	1.28	0.00	0.00	8.99	216	24	216	24
	44	13	151	11.54	0.96	3.21	0.96	0.00	0.00	9.36	145	15	145	15
	45	14	105	7.69	0.64	3.29	0.64	0.00	0.00	9.73	67	7	67	7
	46	15	74	3.85	0.32	3.37	0.32	0.00	0.00	10.11	24	2	24	2
		Σ	4910							Σ	17139	3249	17136	3246
											SCOPon	5.28	SCOPnet	5.28
													SCOP	5.27

Part load performance diagram

- Low temperature application (reference water temperature 35 °C)
- Reference heating season „A“ – average



Test objective:	Seasonal performance tests and SCOP calculation – Medium temperature application
Exact name of the test procedure:	1.37* - Tests of leakage, pressure resistance, thermal and technical parameters, combustion efficiency, safety functions
Test method:	ČSN EN 14511-3:2023, ČSN EN 14825:2023
Sample tested:	Heat pump Montivi-8kW
Measuring equipment used:	see Chapter III

Design			Air / water – monobloc				
Conditions specification according to ČSN 14825:2023	to EN	Temperature application			Medium (reference water temperature 55 °C)		
		Reference heating season			Average		
		Outlet water temperature - indoor heat exchanger			Variable		
		Compressor speed control			Variable		
		Water flow rate – primary circuit			–		
		Water flow rate – secondary circuit			Variable		
Seasonal space heating efficiency	Heating	Average	ηs		142.8	%	
		Warmer	ηs		–	%	
		Colder	ηs		–	%	
Seasonal efficiency according to ČSN 14825:2023	Heating	Average	SCOP		3.64	–	
		Warmer	SCOP		–	–	
		Colder	SCOP		–	–	
Function	Cooling				Yes		
	Heating	Yes	Reference heating season	Average	Yes		
				Warmer	–		
				Colder	–		
Full heating load	Cooling		Pdesignc		–	kW	
	Heating	Average	Pdesignh		7.99	kW	
		Warmer	Pdesignh		–	kW	
		Colder	Pdesignh		–	kW	
Bivalent temperatures	Heating	Average	Tbivalent		-7	°C	
		Warmer	Tbivalent		–	°C	
		Colder	Tbivalent		–	°C	
Operation temperatures limit	Heating	Average	TOL		-10	°C	
		Warmer	TOL		–	°C	
		Colder	TOL		–	°C	
Seasonal consumption according to ČSN EN 14825:2023	power to	Cooling		QCE		–	kWh
		Heating	Average	QHE		4529	kWh
			Warmer	QHE		–	kWh
			Colder	QHE		–	kWh
Modes other than „active mode“		Off mode			POFF	6.3	W
		Thermostat off mode			Pto	5.2	W
		Standby mode			PSB	6.3	W
		Crankcase heater mode			PCK	0.0	W

Calculation of SCOP according to ČSN EN 14825:2023:

Number of hours used for calculation of reference SCOP (Annex B – Table B. 2, B. 3)

- For reversible heat pumps and reference heating season „A“ = average

H _{HE}	2066	[h]
H _{TO}	178	[h]
H _{SB}	0	[h]
H _{CK}	178	[h]
H _{OFF}	0	[h]

Measured data:

P _{TO}	0.0052	[kW]
P _{SB}	0.0063	[kW]
P _{CK}	0.0000	[kW]
P _{OFF}	0.0063	[kW]
P _{designh}	7.99	[kW]
SCOP _{ON}	3.64	[-]

Coefficient and correction:

F(1)	3	[%]
F(2)	0	[%]
CC	2.5	[-]

Calculation of SCOP:

7.3 Calculation of the reference annual heating demand (Q_H)

$$Q_H = P_{\text{designh}} \cdot H_{HE} \quad [\text{kWh}]$$

$$Q_H = 7.99 \cdot 2066 = 16502 \quad [\text{kWh}]$$

7.4 Calculation of the annual electricity consumption (Q_{HE})

$$Q_{HE} = Q_H / \text{SCOP}_{\text{on}} + H_{TO} \cdot P_{TO} + H_{SB} \cdot P_{SB} + H_{CK} \cdot P_{CK} + H_{OFF} \cdot P_{OFF} \quad [\text{kWh}]$$

$$Q_{HE} = 16502 / 3.64 + 178 \cdot 0.0052 + 0 \cdot 0.0063 + 178 \cdot 0 + 0 \cdot 0.0063 = 4529 \quad [\text{kWh}]$$

7.2 General formula for calculation of reference SCOP

$$\text{SCOP} = Q_H / Q_{HE} \quad [-]$$

$$\text{SCOP} = 16502 / 4529 = 3.64 \quad [-]$$

7.1 Calculation of the seasonal space heating efficiency η_s

$$\Sigma F(i) = F(1) + F(2) \quad [-]$$

$$\Sigma F = 0.03 + 0 = 0.03 \quad [-]$$

$$\eta_s = 1 / \text{CC} \cdot \text{SCOP} - \Sigma F(i) \quad [-]$$

$$\eta_s / A = (1 / 2.5) \cdot 3.64 - 0.03 = \underline{\underline{1.428}} \quad [-]$$

Temperature level		Medium (reference water temperature 55 °C)		
Reference heating season		„A“ = average ($T_{designh} = -10\text{ °C}$)		
Assessment condition		A, T _{biv} (F)	B	C
Specification of the assessment condition		A-7/W52	A2/W42	A7/W36
Date of testing		2024-07-18	2024-07-22	2024-07-24
Transient test procedure	YES / NO	NO	NO	NO
Average defrost time of 1 cycle	[min]	–	–	–
Average time of 1 cycle	[min]	–	–	–
Calculation time	[min]	70.0	70.0	70.0
Output heating water – temperature calculation	[°C]	51.99	41.96	36.01
Input heating water – temperature calculation	[°C]	44.01	33.96	29.45
Output heating water temperature	[°C]	51.99	41.96	36.01
Input heating water temperature	[°C]	44.01	33.96	29.45
Air temperature – dry bulb temperature	[°C]	-6.99	1.99	7.00
Air temperature – wet bulb temperature	[°C]	-7.99	1.13	6.01
Relative humidity	[%]	74.96	85.96	87.02
Barometric pressure	[kPa]	99.006	98.195	98.401
Ambient temperature	[°C]	-6.95	1.98	6.93
Secondary circuit pressure difference	[kPa]	24.063	12.350	12.622
Efficiency of the secondary liquid pump	[-]	0.178	0.133	0.130
Volume flow rate of heating water	[m ³ ·h ⁻¹]	0.7727	0.4715	0.3846
Density of heating water	[kg·m ⁻³]	987.5	991.7	993.8
Specific heat capacity of heating water	[kJ·kg ⁻¹ ·K ⁻¹]	4.178	4.175	4.175
Voltage	[V]	402.29	231.82	231.22
Total current	[A]	14.71	6.38	3.65
Overall power input	[kW]	3.301	1.257	0.603
Capacity correction of sec. liquid pump	[W]	23.861	10.542	9.061
Power input correction of sec. liquid pump	[W]	29.03	12.16	10.41
Heating capacity – heating water	[kW]	7.089	4.337	2.906
Corrected heating capacity – heating water	[kW]	7.066	4.327	2.897
Uncertainty of corrected heating capacity	[kW]	± 0.078	± 0.048	± 0.039
Effective electric power input	[kW]	3.272	1.245	0.593
COP	[-]	2.159	3.475	4.888
Uncertainty of COP	[-]	± 0.024	± 0.039	± 0.066
Control settings	[Hz]	64	28	16
Circulation pump settings – heating water	[%]	40	40	40
Fan settings	[rpm]	860	530	330

Temperature level		Medium (reference water temperature 55 °C)	
Reference heating season		„A“ = average ($T_{designh} = -10\text{ °C}$)	
Assessment condition		D	TOL (E)
Specification of the assessment condition		A12/W34.63	A-10/W55
Date of testing		2024-07-19	2024-07-18
Transient test procedure	YES / NO	NO	NO
Average defrost time of 1 cycle	[min]	–	–
Average time of 1 cycle	[min]	–	–
Calculation time	[min]	70.0	70.0
Output heating water – temperature calculation	[°C]	34.52	54.90
Input heating water – temperature calculation	[°C]	28.11	46.90
Output heating water temperature	[°C]	34.52	54.90
Input heating water temperature	[°C]	28.11	46.90
Air temperature – dry bulb temperature	[°C]	12.00	-10.00
Air temperature – wet bulb temperature	[°C]	11.00	-10.93
Relative humidity	[%]	89.03	71.77
Barometric pressure	[kPa]	98.775	98.965
Ambient temperature	[°C]	11.90	-9.94
Secondary circuit pressure difference	[kPa]	12.633	34.284
Efficiency of the secondary liquid pump	[-]	0.130	0.208
Volume flow rate of heating water	[m ³ ·h ⁻¹]	0.3975	0.8155
Density of heating water	[kg·m ⁻³]	994.3	986.1
Specific heat capacity of heating water	[kJ·kg ⁻¹ ·K ⁻¹]	4.175	4.179
Voltage	[V]	232.42	403.03
Total current	[A]	3.18	18.30
Overall power input	[kW]	0.482	4.199
Capacity correction of sec. liquid pump	[W]	9.323	29.617
Power input correction of sec. liquid pump	[W]	10.72	37.38
Heating capacity – heating water	[kW]	2.931	7.493
Corrected heating capacity – heating water	[kW]	2.921	7.463
Uncertainty of corrected heating capacity	[kW]	± 0.040	± 0.083
Effective electric power input	[kW]	0.471	4.162
COP	[-]	6.200	1.793
Uncertainty of COP	[-]	± 0.086	± 0.020
Control settings	[Hz]	14	74
Circulation pump settings – heating water	[%]	40	40
Fan settings	[rpm]	250	860

Data for SCOP calculation

- Medium temperature application (reference water temperature 55 °C)
- Reference heating season „A“ – average

	Outdoor heat exchanger	Indoor heat exchanger	Part load ratio	Part load	DC Declared capacity	COPd at declared capacity	Cdh degradation coefficient	CR	COPbin (Tj)	Eff. power input of compressor off state
	Outdoor air inlet	Outlet water temperature								
	[°C]	[°C]	[%]	[kW]	[kW]	[-]	[-]	[-]	[-]	[kW]
A	-7	52.00	88.46	7.07	7.066	2.159	0.900	1.00	2.159	–
B	2	42.00	53.85	4.30	4.327	3.475	0.900	1.00	3.475	–
C	7	36.00	34.62	2.76	2.897	4.888	0.900	1.00	4.888	–
D	12	34.63	15.38	1.23	2.921	7.463	0.987	0.42	7.329	0.0052
TOL (E)	-10	55.00	100.00	7.99	7.463	1.793	0.900	1.00	1.793	–
Tbiv (F)	-7	52.00	88.46	7.07	7.066	2.159	0.900	1.00	2.159	–

Adaption of water temperature – according to ČSN EN 14825:2023, Annex E

- Medium temperature application (reference water temperature 55 °C)
- Reference season „A“ – average
- Condition D
- Variable water flow rate – secondary circuit

General formulas and derivation:

$$\begin{aligned}
 t_{\text{outlet, average}} &= t_{\text{inlet, capacity test}} + (t_{\text{outlet, capacity test}} - t_{\text{inlet, capacity test}}) \cdot CR & [\text{°C}] \\
 t_{\text{outlet, average}} &= t_{\text{inlet, capacity test}} + (\Delta t) \cdot CR & [\text{°C}] \\
 t_{\text{outlet, average}} &= t_{\text{outlet, capacity test}} - \Delta t + \Delta t \cdot CR & [\text{°C}] \\
 t_{\text{outlet, capacity test}} &= t_{\text{outlet, average}} + \Delta t - \Delta t \cdot CR & [\text{°C}]
 \end{aligned}$$

For variable flow:

$$\Delta t = 8$$

$$CR \cdot \Delta t = \text{Part load} / \text{Declared capacity} \cdot 8$$

$$t_{\text{outlet, capacity test, variable flow}} = t_{\text{outlet, average}} + 8 - \text{Part load} / \text{Declared capacity} \cdot 8$$

Measured data:

$t_{\text{outlet, average}}$	30.00	[°C]
Declared capacity	2.921	[kW]
Declared capacity standard rating condition A7/W55	-	[kW]
Part load	1.23	[kW]

Calculation of water temperature

$$t_{\text{outlet, capacity test, variable flow}} = 30 + 8 - 1.23 / 2.921 \cdot 8 = \underline{\underline{34.63}} \quad [\text{°C}]$$

Calculation SCOP, SCOP_{on}, SCOP_{net}

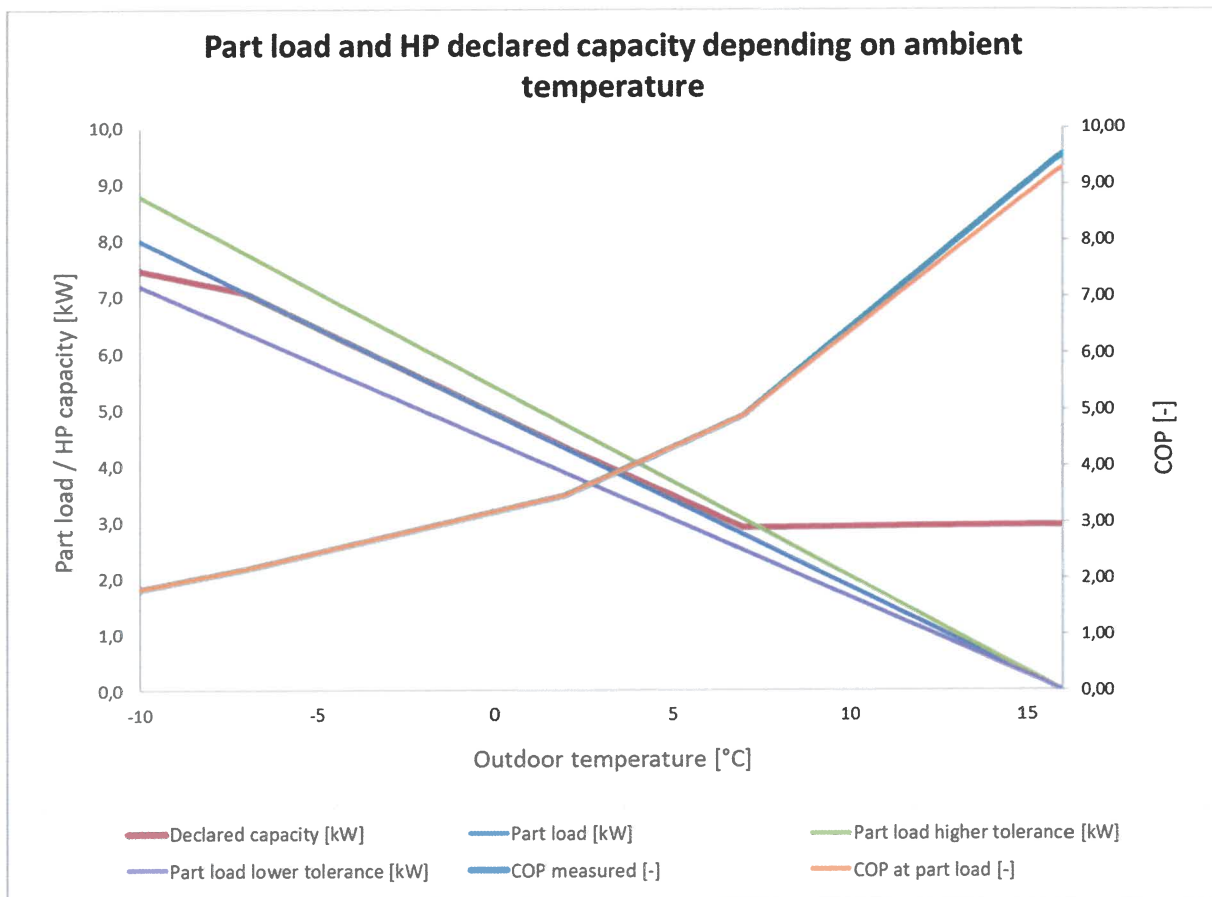
- Medium temperature application (reference water temperature 55 °C)
- Reference heating season „A“ – average

	Bin	Outdoor temp. (dry bulb)	Hours	Part load ratio	Heat load	Capacity of HP	Heat load covered by heat pump	Resistive heat elbu (Tj)	Annual resistive heat	COP _{bin} (Tj)	Annual heating demand	Annual power input including electric back up heating	Net annual heating capacity	Net annual power input without electric back up heating
	j	Tj	h _j		Ph(Tj)			elbu(Tj)	h _j x elbu(Tj)	COP _{bin} in (Tj)	h _j x P _h (Tj)		h _j x (P _h (Tj) - elbu(Tj))	
	[-]	[°C]	[h]	[%]	[kW]	[kW]	[kW]	[kW]	[kWh]	[-]	[kWh]	[kWh]	[kWh]	[kWh]
TOL (E)	21	-10	1	100.00	7.99	7.46	7.46	0.52	0.52	1.79	8	5	7	4
	22	-9	25	96.15	7.68	7.33	7.33	0.35	8.74	1.92	192	104	183	96
	23	-8	23	92.31	7.37	7.20	7.20	0.17	4.02	2.04	170	85	166	81
A, T_{biv} (F)	24	-7	24	88.46	7.07	7.07	7.07	0.00	0.00	2.16	170	79	170	79
	25	-6	27	84.62	6.76	6.76	6.76	0.00	0.00	2.31	182	79	182	79
	26	-5	68	80.77	6.45	6.46	6.45	0.00	0.00	2.45	439	179	439	179
	27	-4	91	76.92	6.14	6.15	6.14	0.00	0.00	2.60	559	215	559	215
	28	-3	89	73.08	5.84	5.85	5.84	0.00	0.00	2.74	520	189	520	189
	29	-2	165	69.23	5.53	5.54	5.53	0.00	0.00	2.89	912	316	912	316
	30	-1	173	65.38	5.22	5.24	5.22	0.00	0.00	3.04	904	298	904	298
	31	0	240	61.54	4.92	4.94	4.92	0.00	0.00	3.18	1180	371	1180	371
	32	1	280	57.69	4.61	4.63	4.61	0.00	0.00	3.33	1290	388	1290	388
B	33	2	320	53.85	4.30	4.33	4.30	0.00	0.00	3.48	1376	396	1376	396
	34	3	357	50.00	3.99	4.04	3.99	0.00	0.00	3.76	1426	379	1426	379
	35	4	356	46.15	3.69	3.76	3.69	0.00	0.00	4.04	1312	325	1312	325
	36	5	303	42.31	3.38	3.47	3.38	0.00	0.00	4.32	1024	237	1024	237
	37	6	330	38.46	3.07	3.18	3.07	0.00	0.00	4.61	1014	220	1014	220
C	38	7	326	34.62	2.76	2.90	2.76	0.00	0.00	4.89	901	184	901	184
	39	8	348	30.77	2.46	2.90	2.46	0.00	0.00	5.38	855	159	855	159
	40	9	335	26.92	2.15	2.91	2.15	0.00	0.00	5.86	720	123	720	123
	41	10	315	23.08	1.84	2.91	1.84	0.00	0.00	6.35	581	91	581	91
	42	11	215	19.23	1.54	2.92	1.54	0.00	0.00	6.84	330	48	330	48
D	43	12	169	15.38	1.23	2.92	1.23	0.00	0.00	7.33	208	28	208	28
	44	13	151	11.54	0.92	2.93	0.92	0.00	0.00	7.82	139	18	139	18
	45	14	105	7.69	0.61	2.93	0.61	0.00	0.00	8.31	65	8	65	8
	46	15	74	3.85	0.31	2.94	0.31	0.00	0.00	8.79	23	3	23	3
	Σ		4910							Σ	16499	4527	16486	4514

SCOP _{on}	3.64	SCOP _{net}	3.65
		SCOP	3.64

Part load performance diagram

- Medium temperature application (reference water temperature 55 °C)
- Reference heating season „A“ – average



Tested by: Ing. Tomáš Sedláček

Date: 2024-08-21

Signed:

Sedláček

Reviewed and approved by: Ing. Michal Faltýnek

Date: 2024-08-21

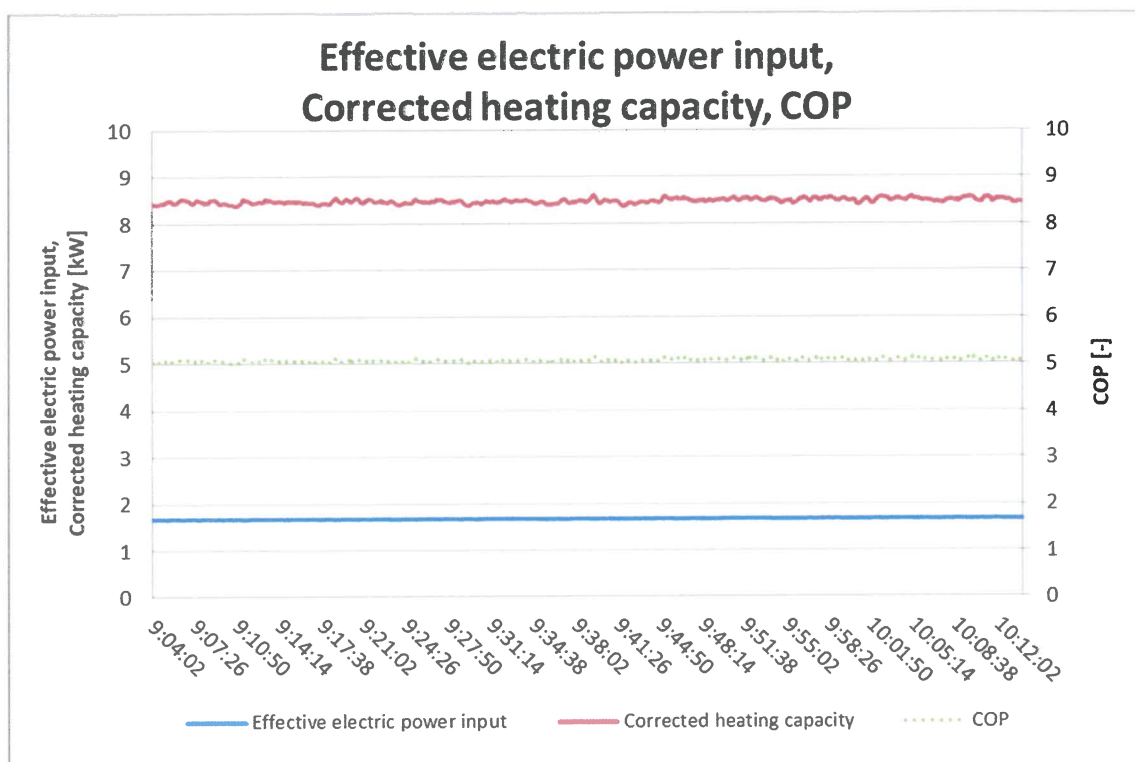
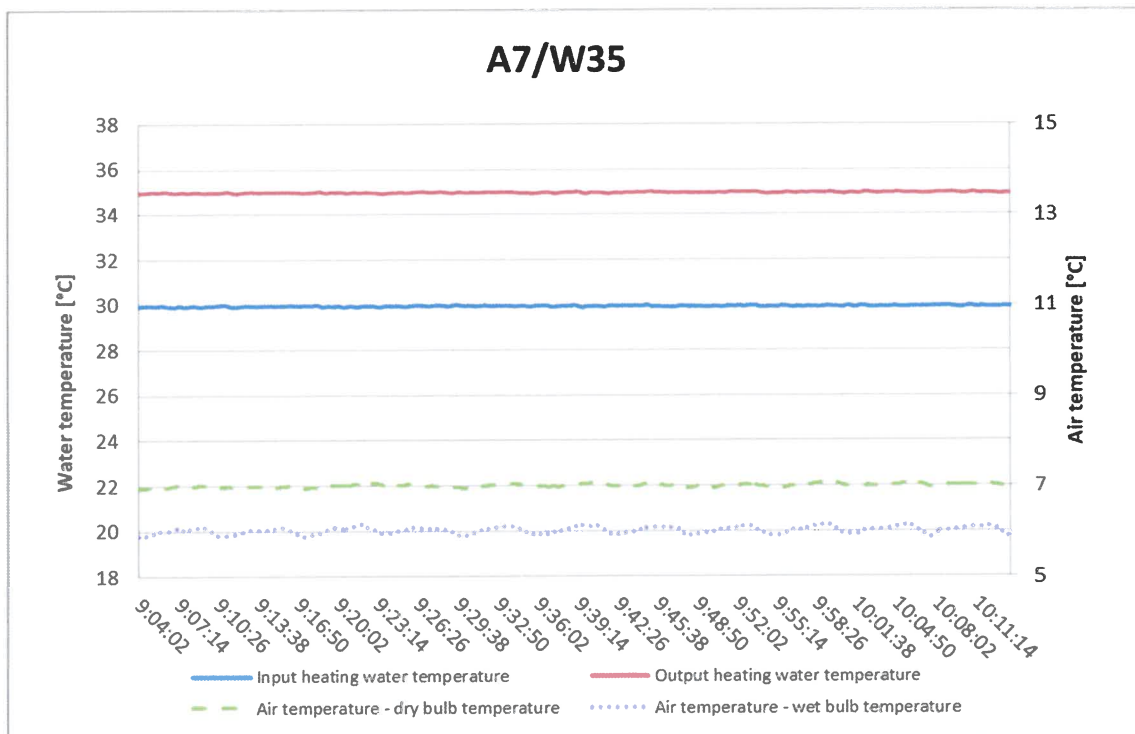
Signed:

Faltýnek

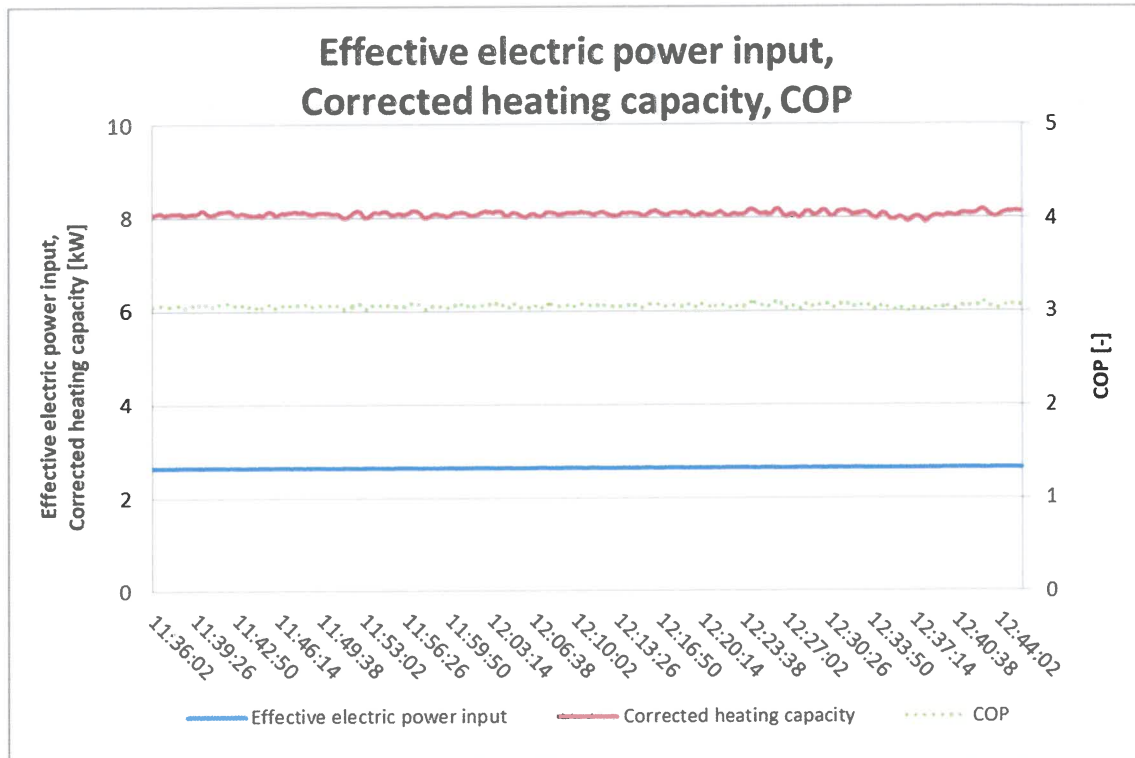
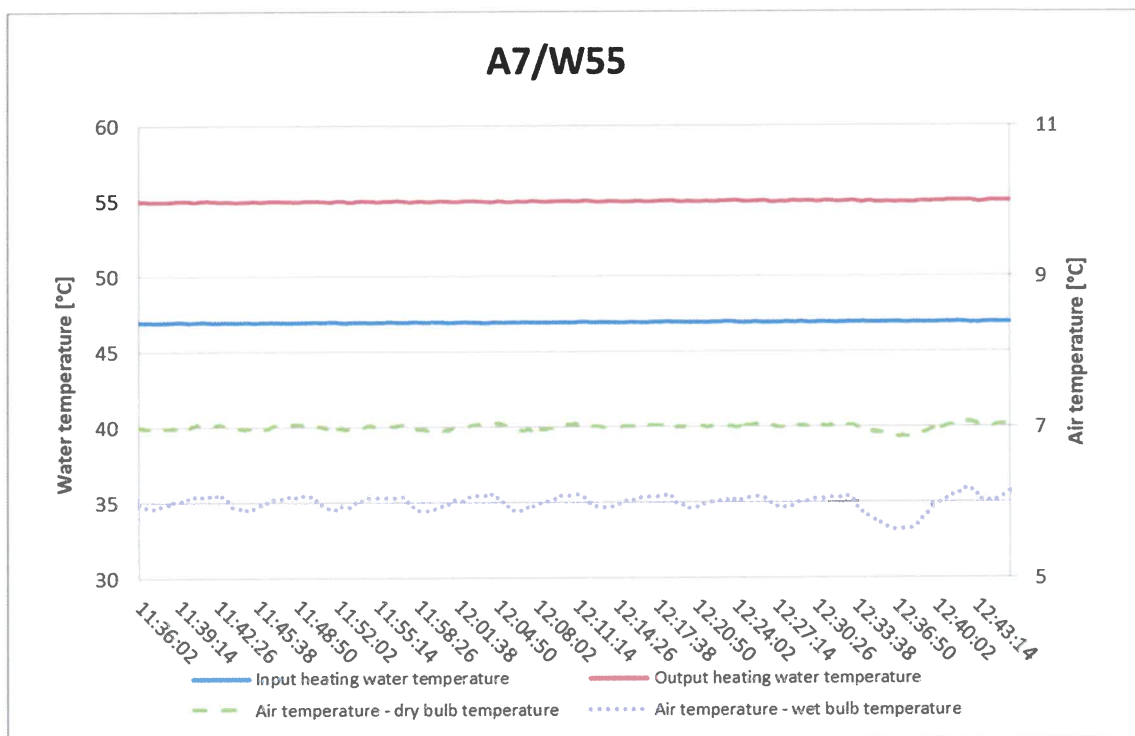
V. Graphs

1. Rating conditions

A7/W35 (44 Hz)

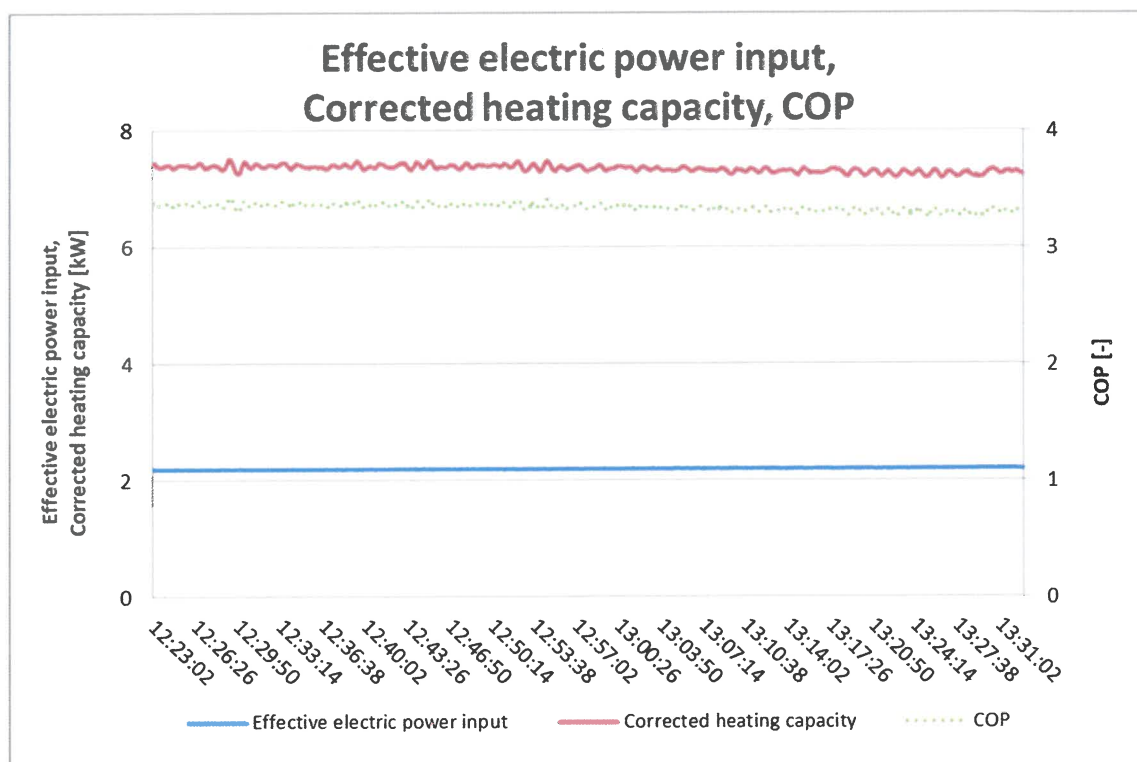
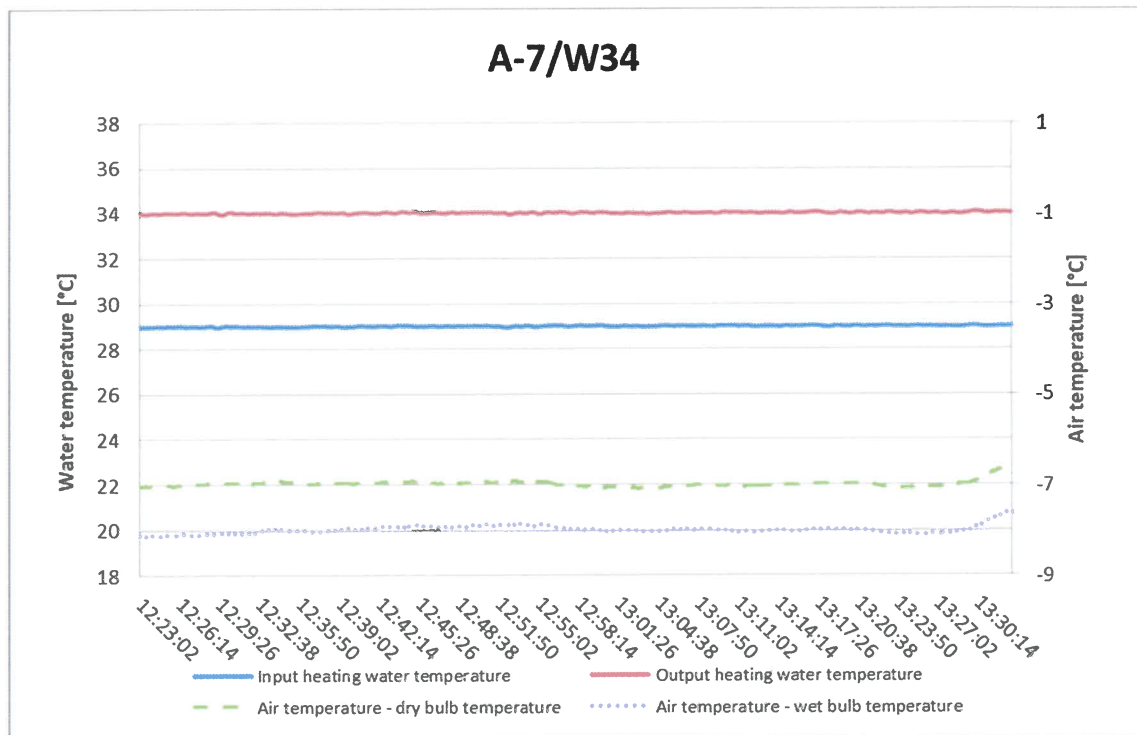


A7/W55 (46 Hz)

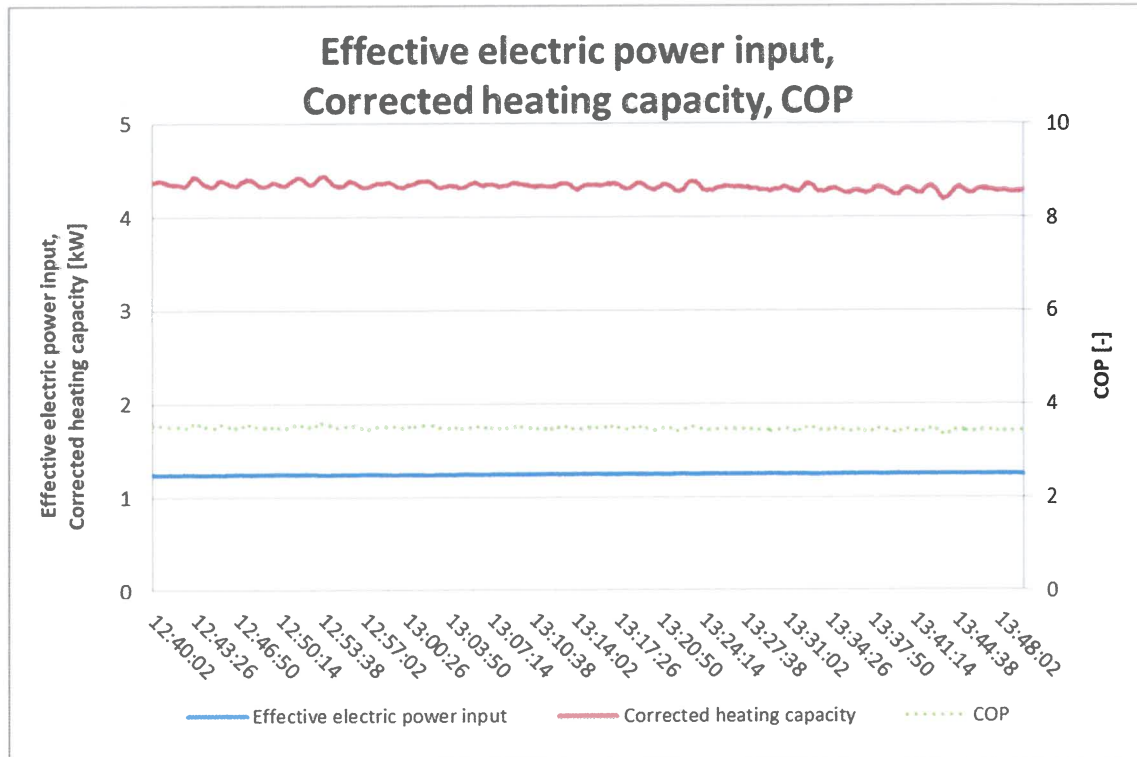
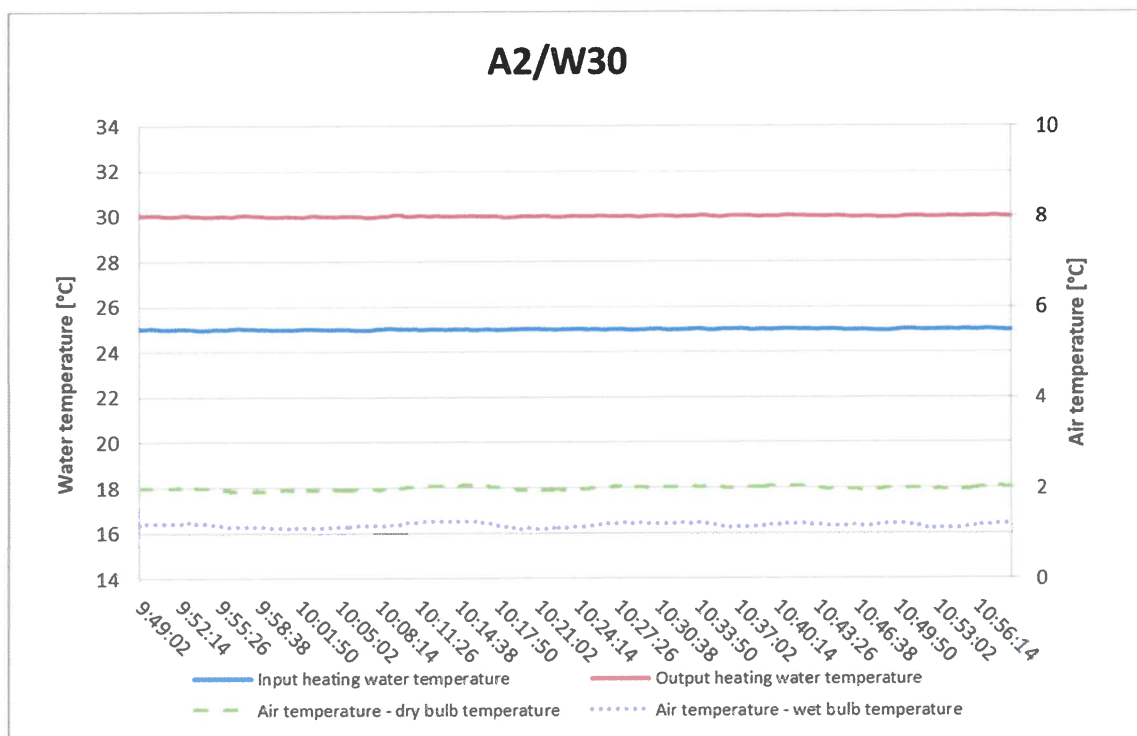


2. Seasonal performance tests and SCOP calculation – Low temperature application

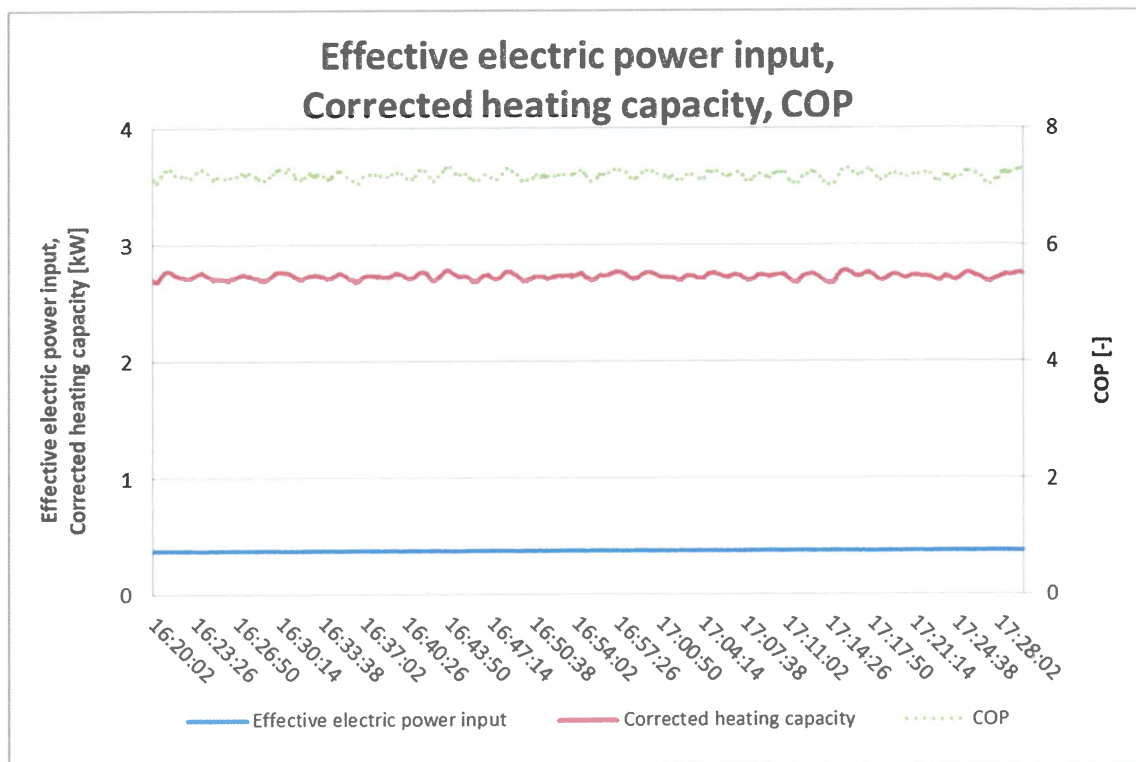
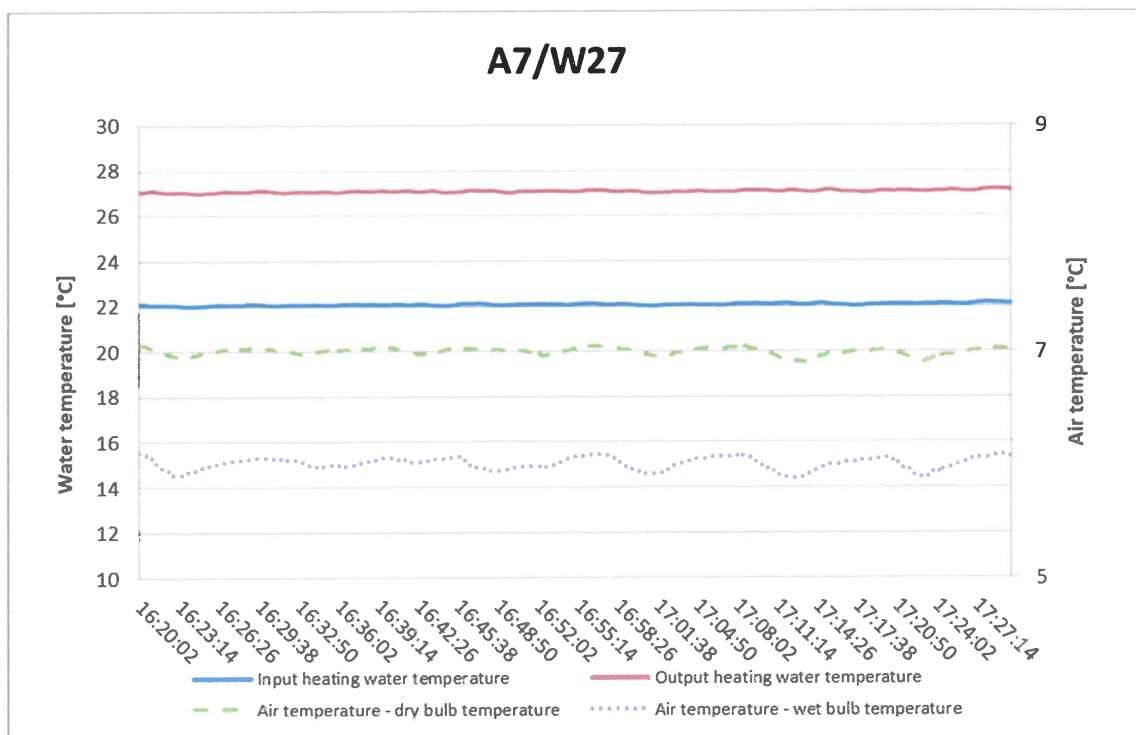
A-7/W34 (59 Hz)



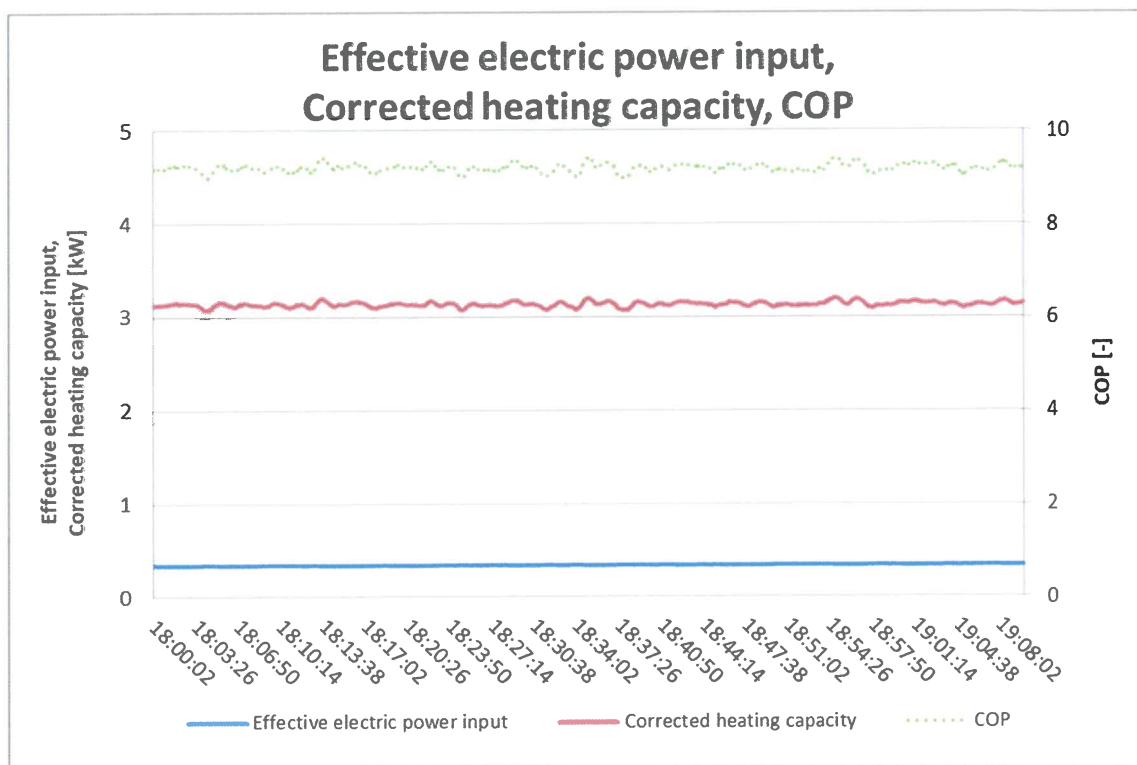
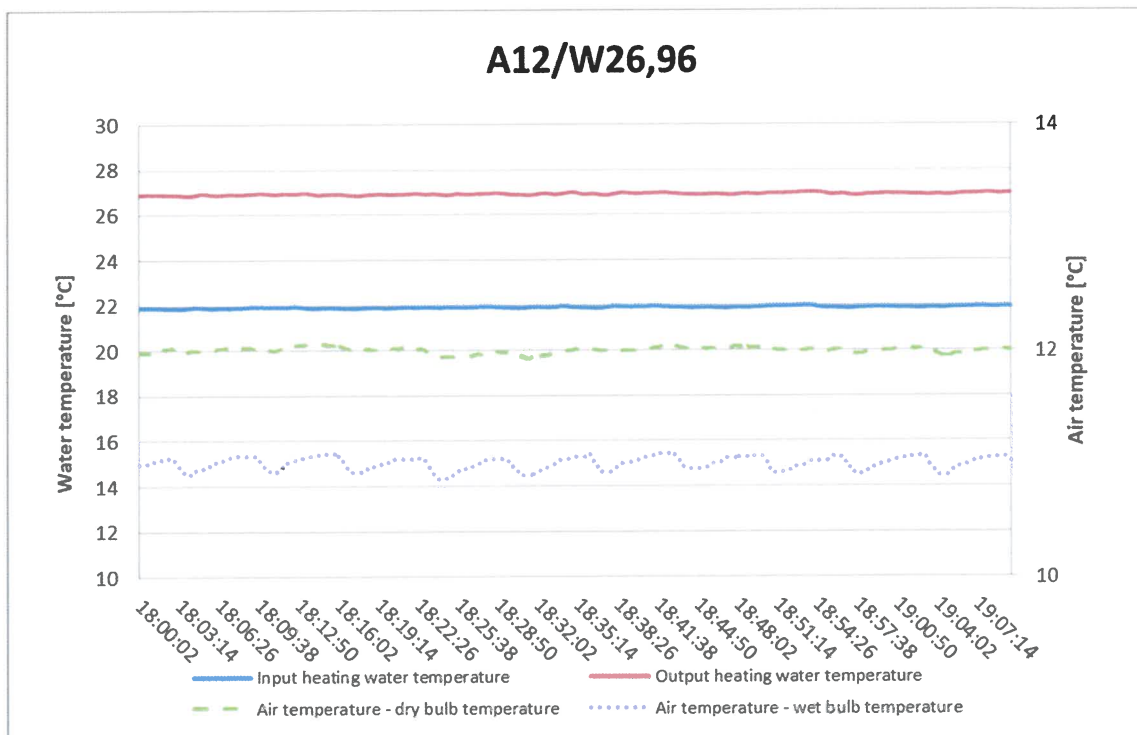
A2/W30 (25 Hz)



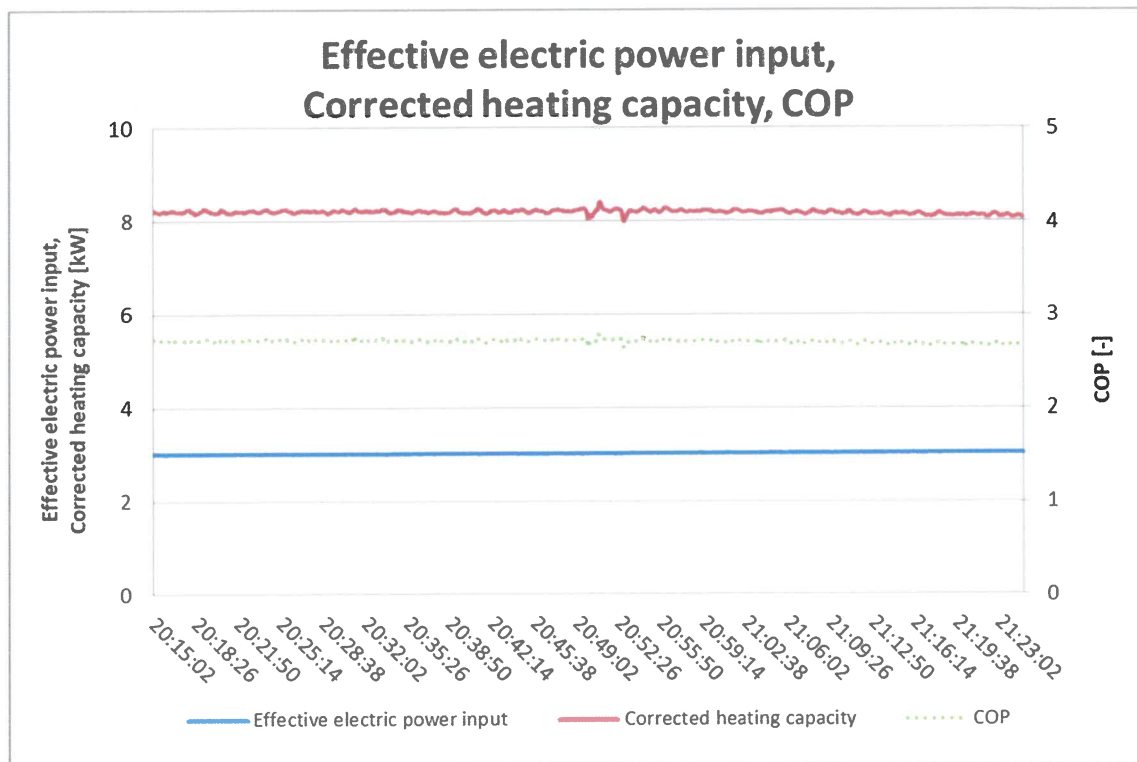
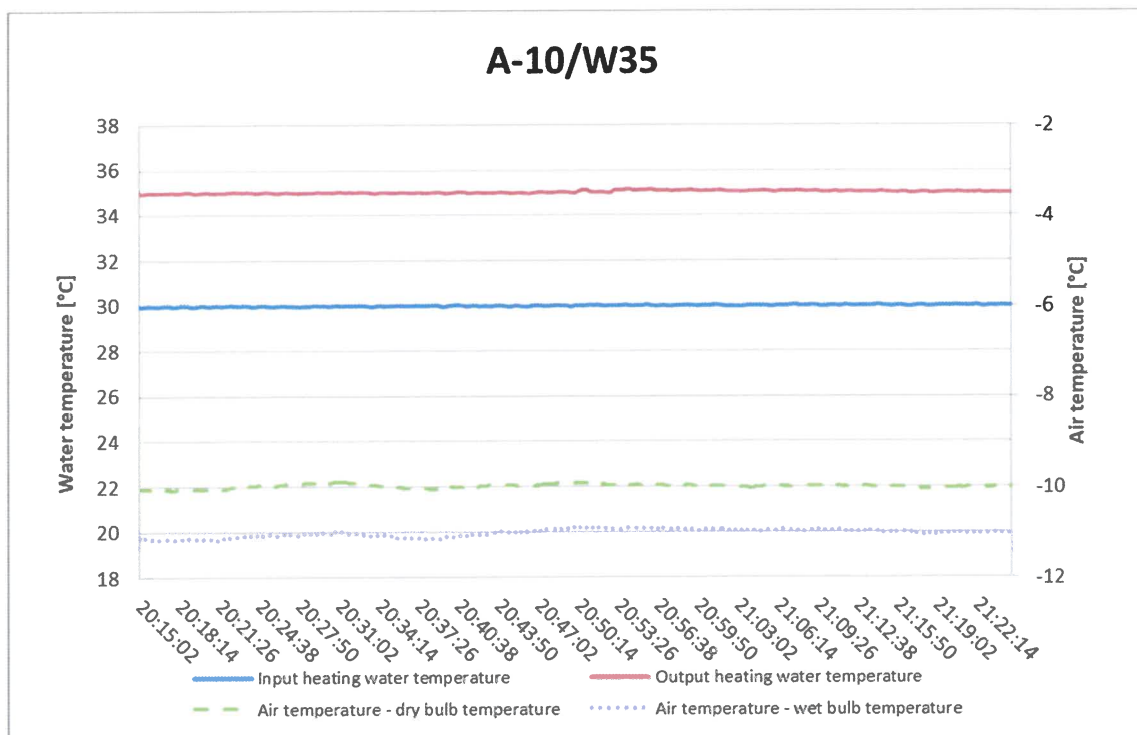
A7/W27 (14 Hz)



A12/W26.96 (14 Hz)

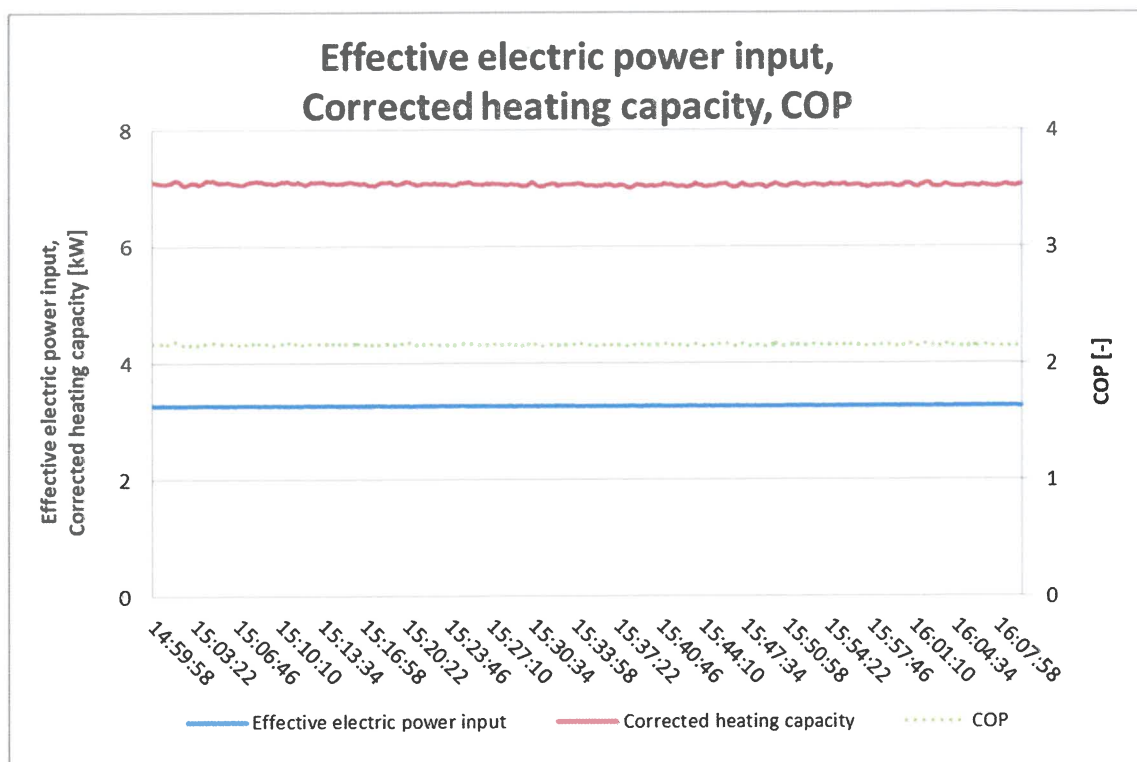
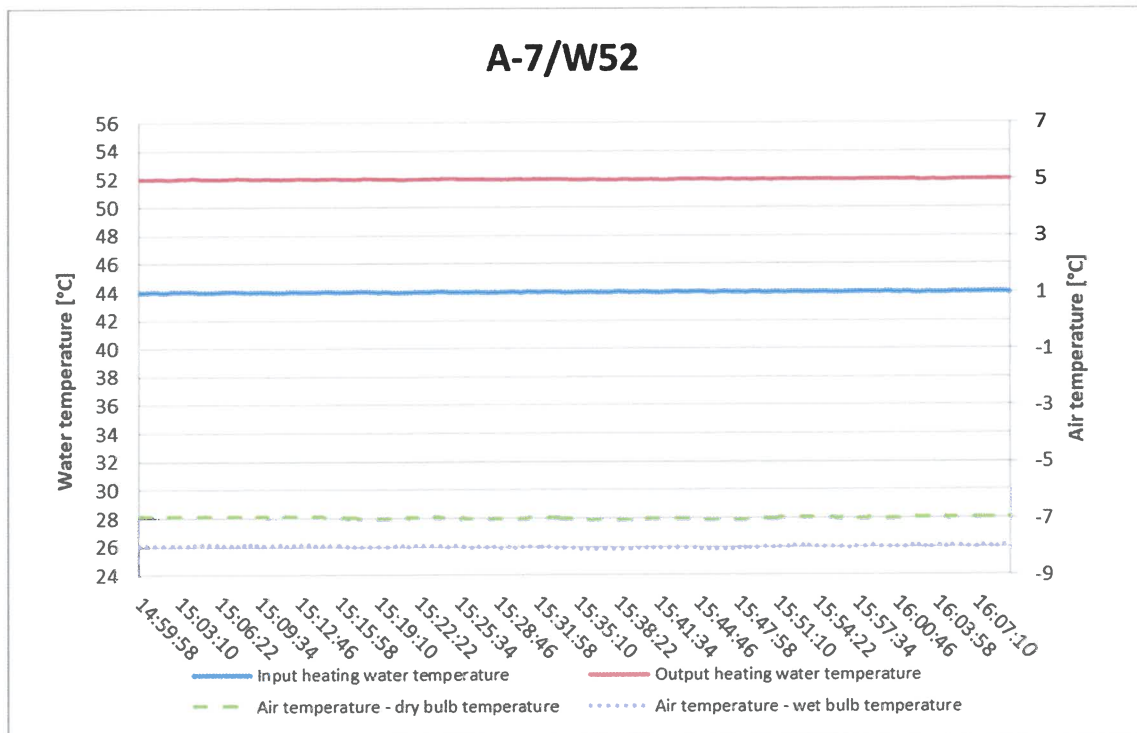


A-10/W35 (74 Hz)

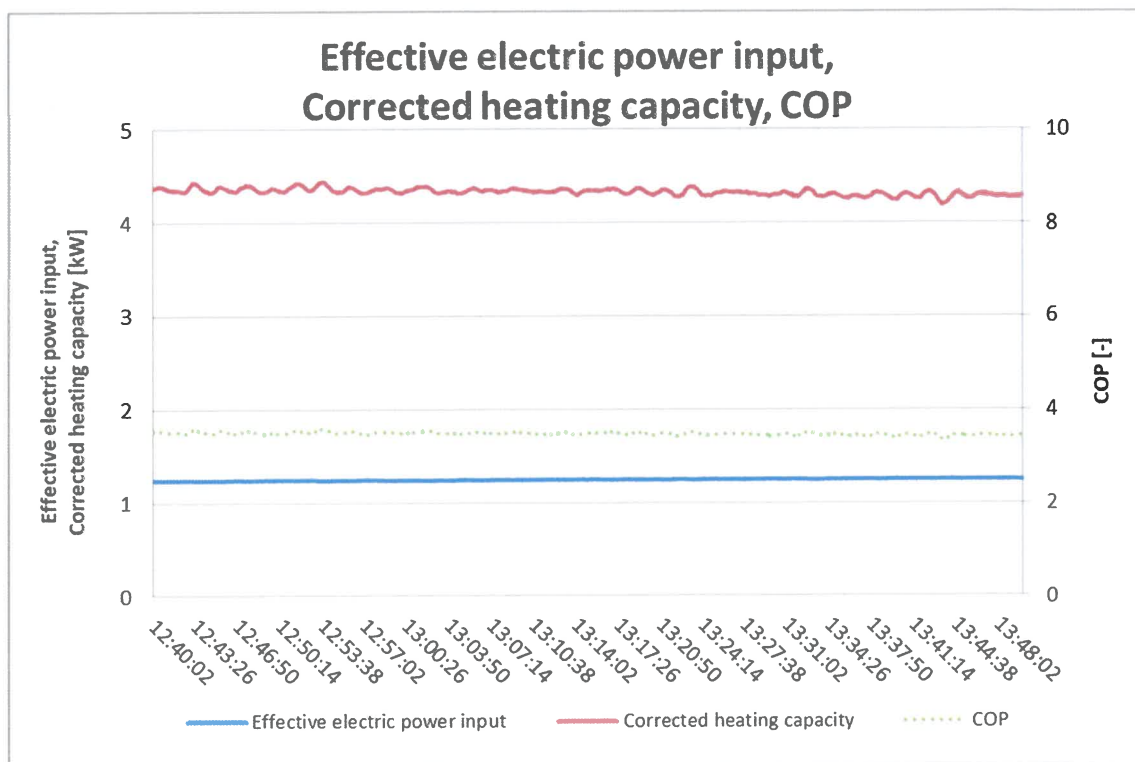
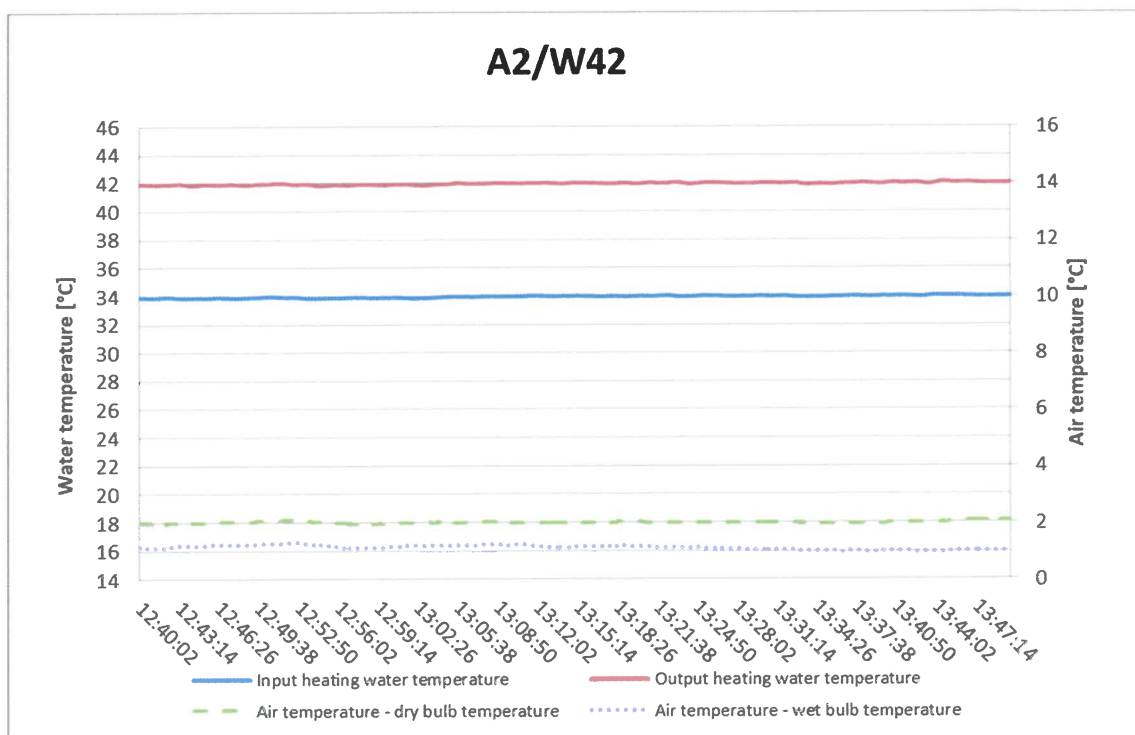


3. Seasonal performance tests and SCOP calculation – Medium temperature application

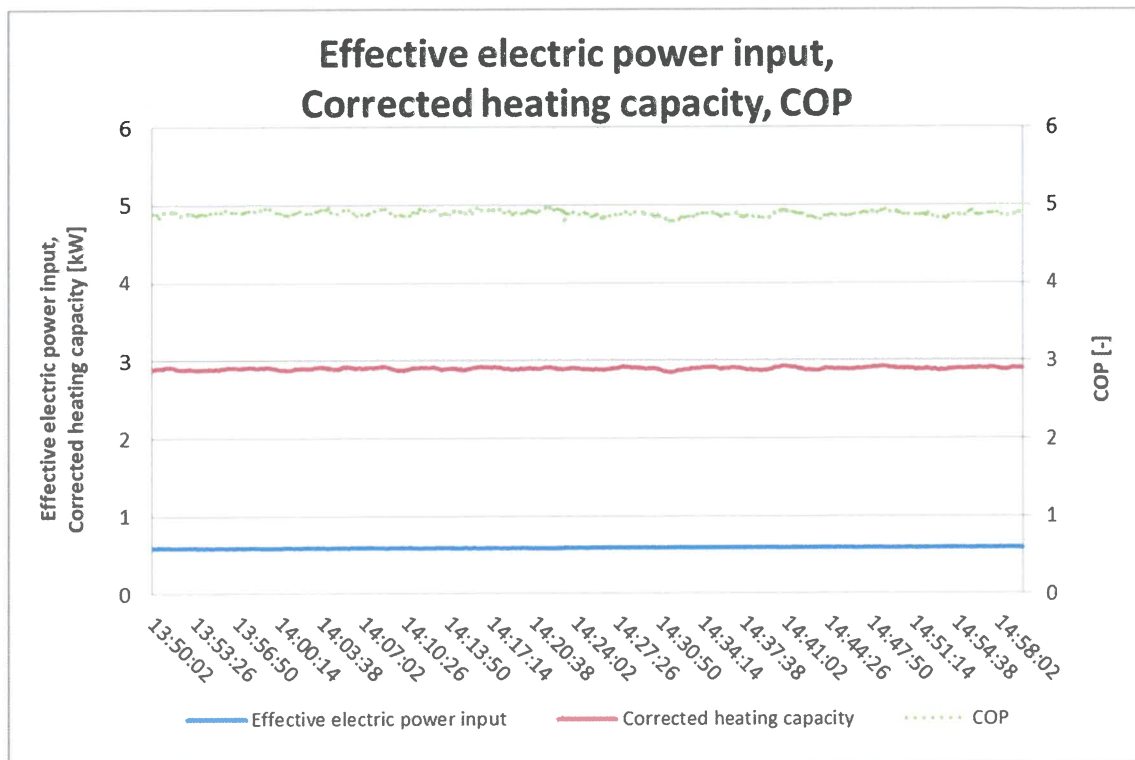
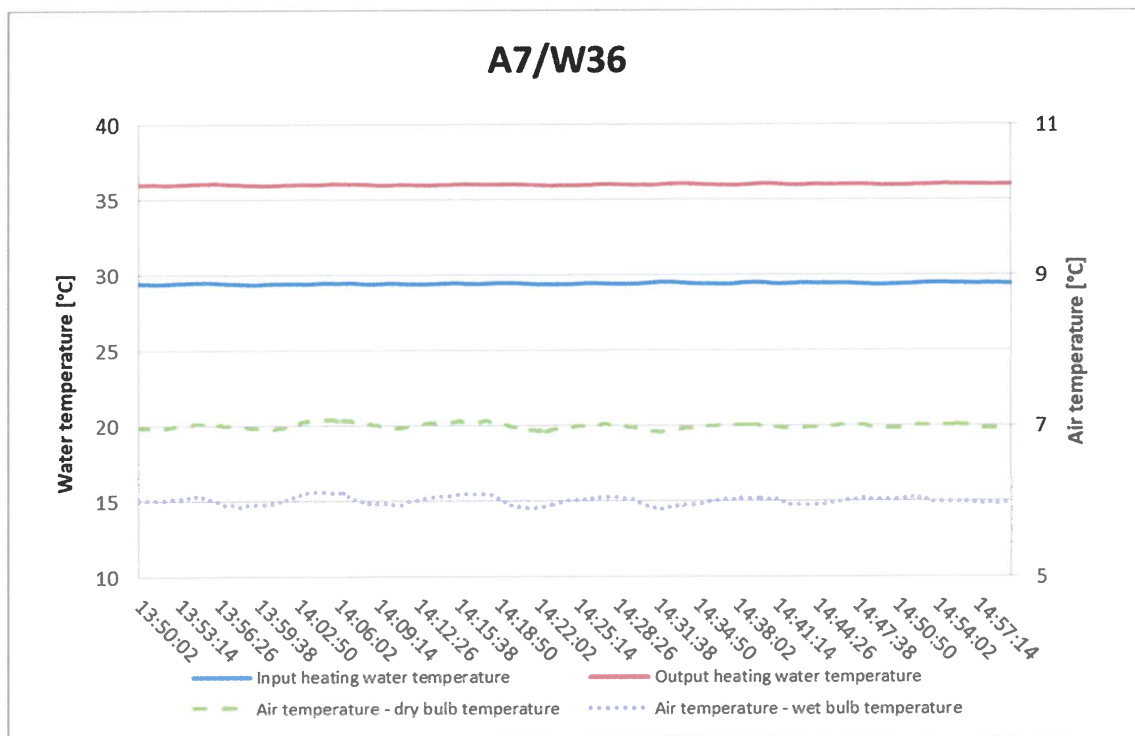
A-7/W52 (64 Hz)



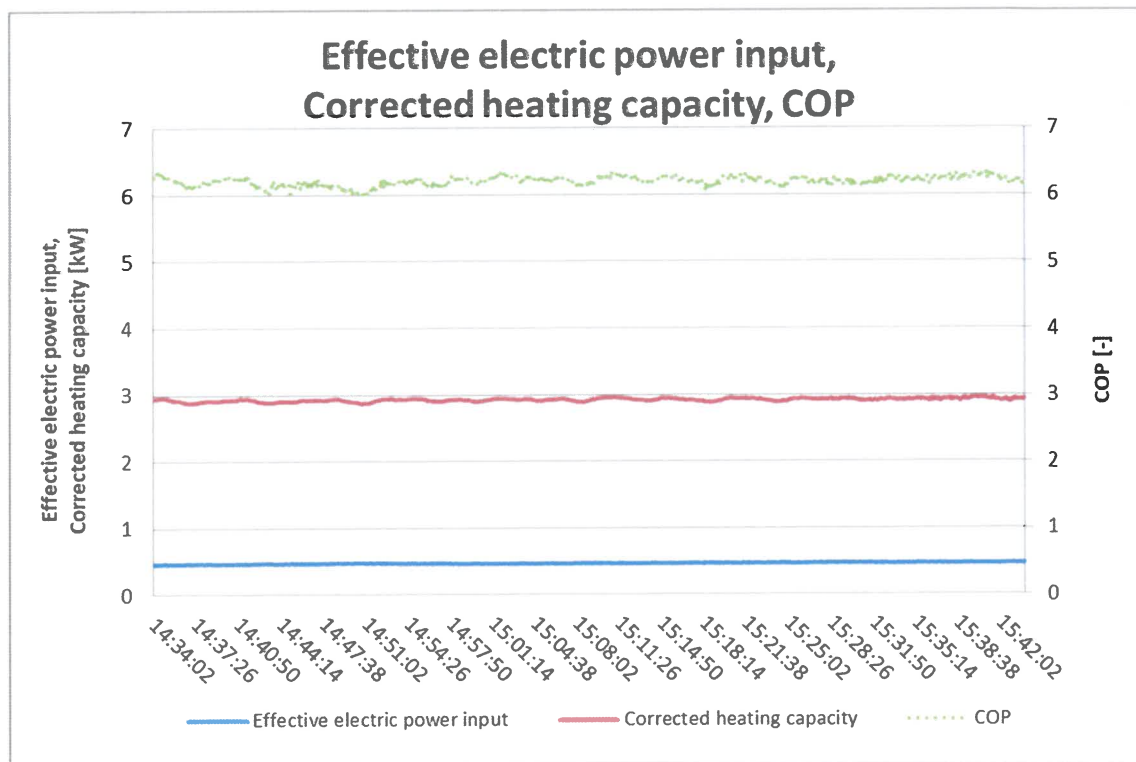
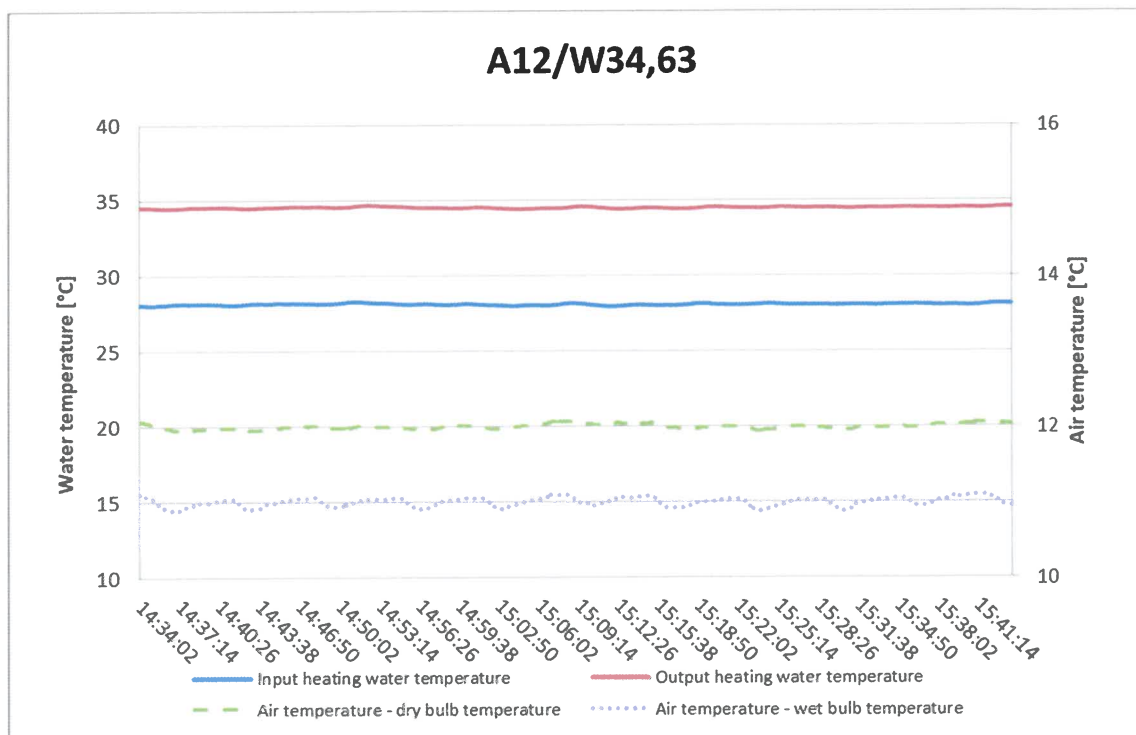
A2/W42 (28 Hz)



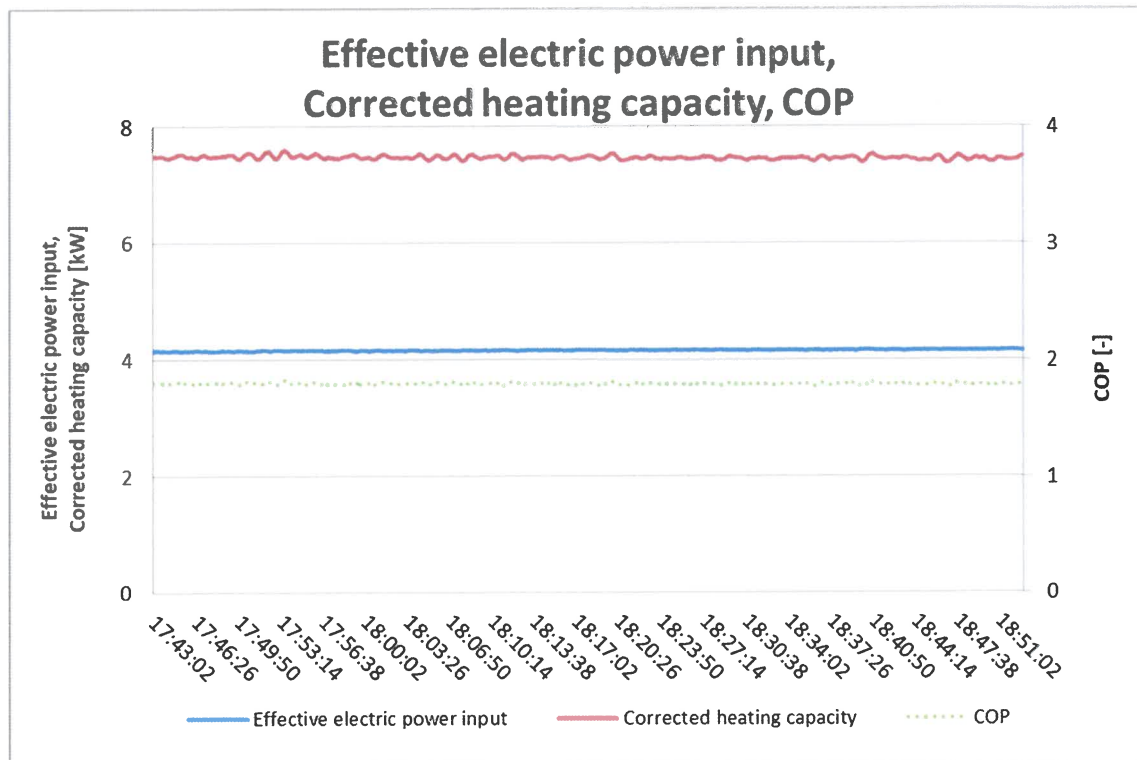
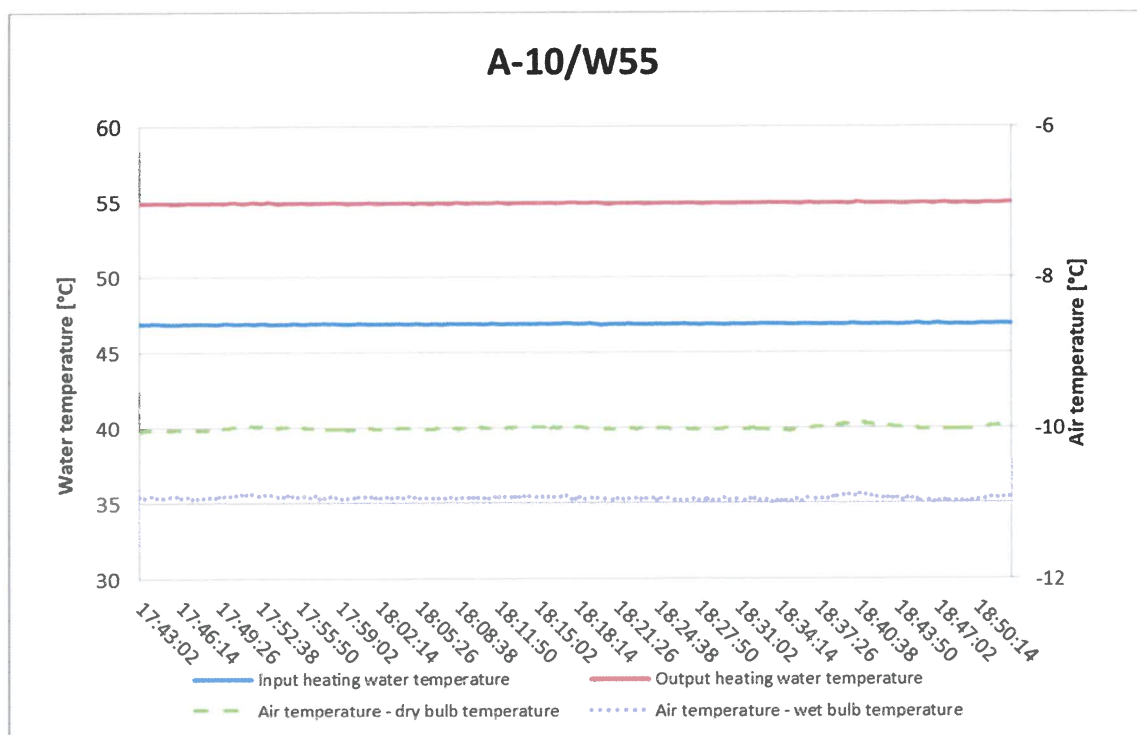
A7/W36 (16 Hz)



A12/W34.63 (14 Hz)



A-10/W55 (74 Hz)



VI. A list of referenced documents

- Order B-81819 of 2024-03-18 (Order reg. no. B-81819, received on 2024-03-18)
- Contract B-81819
- ČSN EN 14511-2:2023 - Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors - Part 2: Test conditions
- ČSN EN 14511-3:2023 - Air conditioners, liquid chilling packages and heat pumps for space heating and cooling a process chillers with electrically driven compressors - Part 3: Test methods
- ČSN EN 14825:2023 - Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling - Testing and rating at part load conditions and calculation of
- Background of the task 39-17652
- Record measurement file 39-17652

Test Report compiled by:

Ing. Tomáš Sedláček



Test Report approved by:

Ing. Mario Jankola
Heating Equipment and Construction Products Manager



– End of Test Report –