Hortinergy

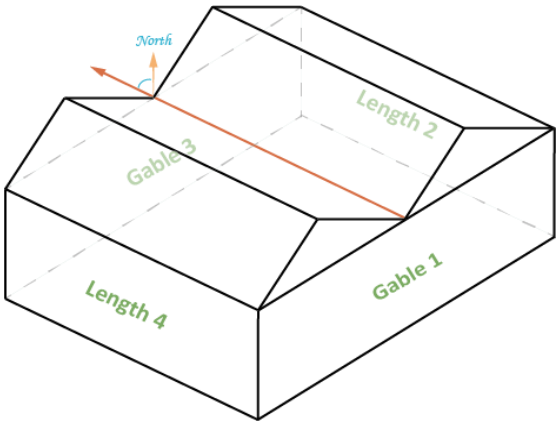
Energy and climate analysis for greenhouse project

Project name : CannabisLemington

Scenario :	Tomato Ontario 2
Site:	
Latitude [°] =	42.103234
Longitude [°] =	-82.590057
Altitude [m] =	100

Version: 2.1 Full

Date: 28/09/2025



A. Project parameters

1. Greenhouse design

Length (m)	100
Span – chapel width (m)	4.8
Width (m)	96
Area (m²)	9 600
Roof height (m)	7.8
Gutter height (m)	7
Greenhouse type	saw tooth

	Roof	Gable 1	Length 2	Gable 3	Length 4
Cover	4mm clear glass	Opaque (5 cm insulation)	Opaque (5 cm insulation)	Opaque (5 cm insulation)	Opaque (5 cm insulation)
Frame percentage	10	10	10	10	10
Screen number	2	0	0	0	0
Screen 1 type	Black out	-	-	-	-
Shade %	99	-	-	-	-
Energy saving %	60	-	-	-	-
Screen 2 type	Thermal	-	-	-	-
Shade %	13	-	-	-	-
Energy saving %	47	-	-	-	-
Screen 3 type	-				
Shade %	-				
Energy saving %	-				

2. Crop production

Type of crop	Cannabis (Flowering)
Cultivation starting date	2020-01-01
End of cultivation	2020-12-31
Seedling age	2 weeks at transplantation

3. Climate management

a. Period and temperature setting

	Temperature setting (°C)		
	day	night	-
Period 1			
2020-01-01 2020-12-31	21	17	-
Periode 2			
- -	-	-	-
Period 3			
- -	-	-	-
Period 4			
- -	-	-	-
Period 5			
- -	-	-	-
Period 6			
- -	-	-	-

c. Humidity set

Humidity regulation:	Relative humidity

Period	Unit	Min	Max
Day	%	50	90
Night	%	50	90

d. Day / Night switch - screen regulation

Screen use

	Roof	Gable 1	Length 2	Gable 3	Length 4
Screen number	2	0	0	0	0
Screen 1 type	Black out	-	-	-	-
Regulation 1	Thermal & Black out				
Screen 2 type	Thermal	-	-	-	-
Regulation 2	Thermal				
Screen 3 type	-				
Regulation	-				

d1. Day / Night switch - thermal screen regulation

	Screen 1	Screen 2	Screen 3
Regulation type	Solar radiation	Solar radiation	0
Minimum solar radiation	10 W/m²	100 W/m²	0 W/m²
Min Delta temperature in/out	-	-	-

d2. Shade screen regulation

	Screen 1	Screen 2	Screen 3
Regulation type	Solar radiation	Solar radiation	Solar radiation
Minimum solar radiation	0 W/m²	0 W/m²	0 W/m²
Shade screen as thermal	0	0	0

d3. Black out regulation

Beginning	End	Min hours/day with blackout
2025-01-01	2025-12-31	10

Black out as thermal - light pollution	yes
Minimum solar radiation	1 W/m²

5. Cooling, humidification and semi-closed systems

Semi-closed greenhouse:	Yes

Air flow

Air flow max rate (m^3/m^2 h):	94

Fan specification

Max air flow /fan (m^3/h fan)	15000

Electricity consumtion per fan according to air flow percentage (Watt)	
100%	1000
66%	600
33%	200
1%	100

Humidification and cooling:	Pad
Max evoporating capacity (m3/h):	1000000
Pad thickness (mm)	150
Pad height (cm)	200
Pad lengh (% of gable)	95
Flush (%)	30
Temperature of water (°C)	-
Distance between pad and fan (m)	-

Temperature sets and regulation

	day	**night**
Cooling temperature (°C):	28	20
Vent opening temp. (°C):	49	49
Priority:	Humidification	

Electricty cost (C$/MWh)	90

6. Closed greenhouse

Closed greenhouse	no

	day	**night**	**Overpressure (m3/m² h)**
Cooling temperature (°C)	-	-	0.00

7. Supplemental lighting

Supplemental light	Yes
Type of light	LED
Light management	DLI

	LED	HPS
Input power (µmol/ s m²)	300	-
Efficiency (µmol/J)	3.00	-

		Hours of lighting		
	Total DLI (Mol/Day/m²)	Hour light switch on	Hour light switch off	Outside light level above light switch off (W/m²)
Jan	20	-	-	-
Feb	20	-	-	-
Mar	20	-	-	-
Apr	20	-	-	-
May	20	-	-	-
Jun	20	-	-	-
Jul	20	-	-	-
Aug	20	-	-	-
Sep	20	-	-	-
Oct	20	-	-	-
Nov	20	-	-	-
Dec	20	-	-	-

8. Heat production

Dimensionning User defined (advanced parameters)

Heating	Main	Auxiliary	Additional
Energy source	CHP - recovery heat	Gas	-
Unit price (C$/MWh)	30	60	-
Maximum power	800	5 000	-
Condensor	Yes	No	-
Max efficiency (%)	100	90	-

Energy period	Start	End
Main	2020-01-01	2020-12-31
Second	2020-01-01	2020-12-31

Distribution efficiency (%)	95

Buffer tank	Yes
Volume (m^3)	400
Height (m)	10
Insulation (cm)	20
Temperature differance	40
Peak shaving	No
Electricty cost (C$/MWh)	90

CO2	
Injection	Yes
target ppm	900
Min W/m²	100
if vent Open	2025-09-01
Beginning	2025-12-31
End	No

9. Outdoor climate

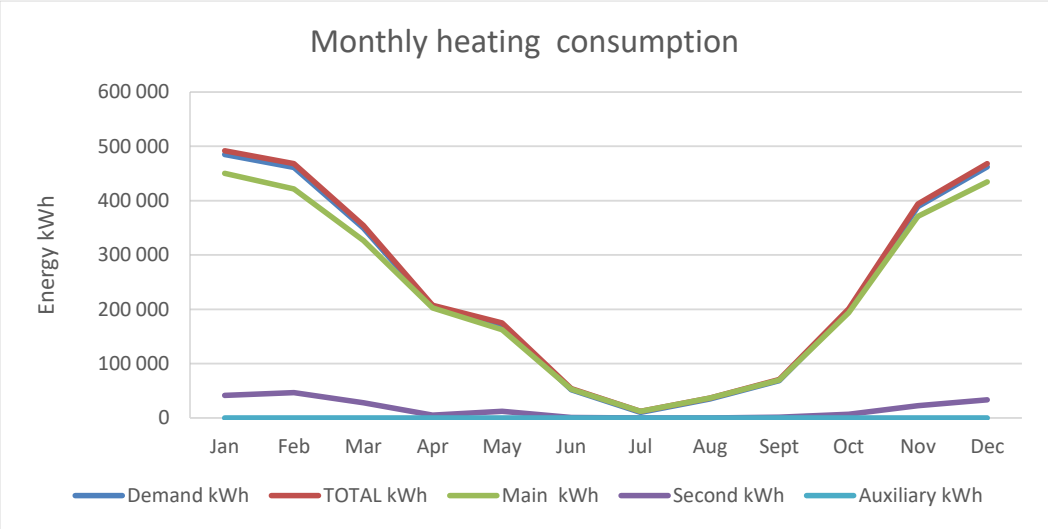
Month	Average outdoor temperature (°C)	Mimimum outdoor temperature (°C)	Maximum outdoor temperature (°C)	External average relative humidity (%)	External average global solar radiation (kWh/ m² day)
January	-3.2	-16.5	9.7	75	1.61
February	-2.5	-14.7	11.2	74	2.28
March	2.3	-10.4	20.2	70	3.49
April	8.5	-3.1	23.8	67	4.38
May	15.0	3.1	30.1	70	5.37
June	20.2	8.8	30.8	71	6.06
July	23.2	13.0	34.5	70	5.96
August	22.4	12.7	32.6	73	5.01
September	18.4	7.3	30.0	76	4.18
October	12.0	1.7	23.6	73	2.82
November	5.5	-4.2	19.8	75	1.59
December	-0.3	-12.4	12.3	78	1.26
Average/ Min /Max	10.1	-16.5	34.5	73	3.68

B. Energy consumption

1. Annual heating cost and energy consumption

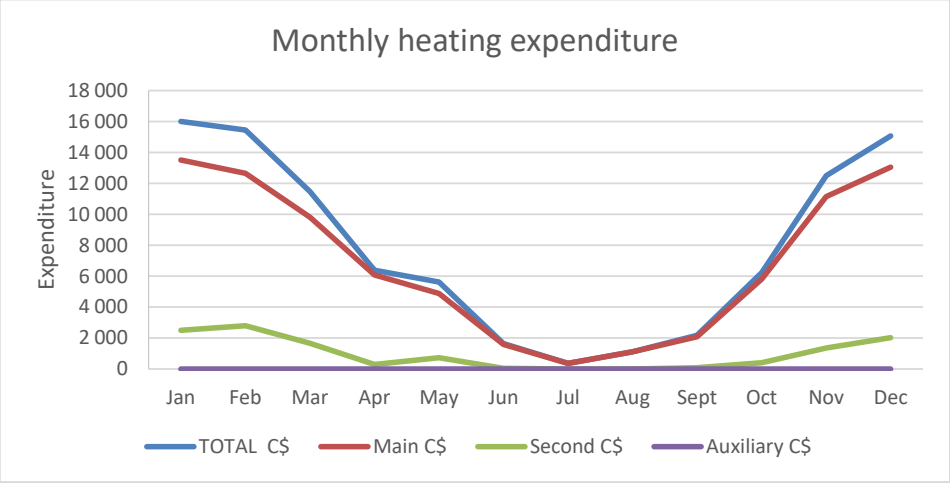
	Total	Main	Second	Auxiliary
Energy source		CHP - recovery heat	Gas	-
Unit price (C$/MWh)		30	60	-
Expenditure (C$)	93 997	82 066	11 932	-
C$ /m²	9.8	8.5	1.2	-
Main vs Auxiliary (cost %)		87%	13%	-
Consumption MWh	2 934	2 736	199	-
Consumpt. / unit (kWh/m²)	306	285	21	-
Main vs Auxiliary (energy %)		93%	7%	-

2. Monthly heating consumption



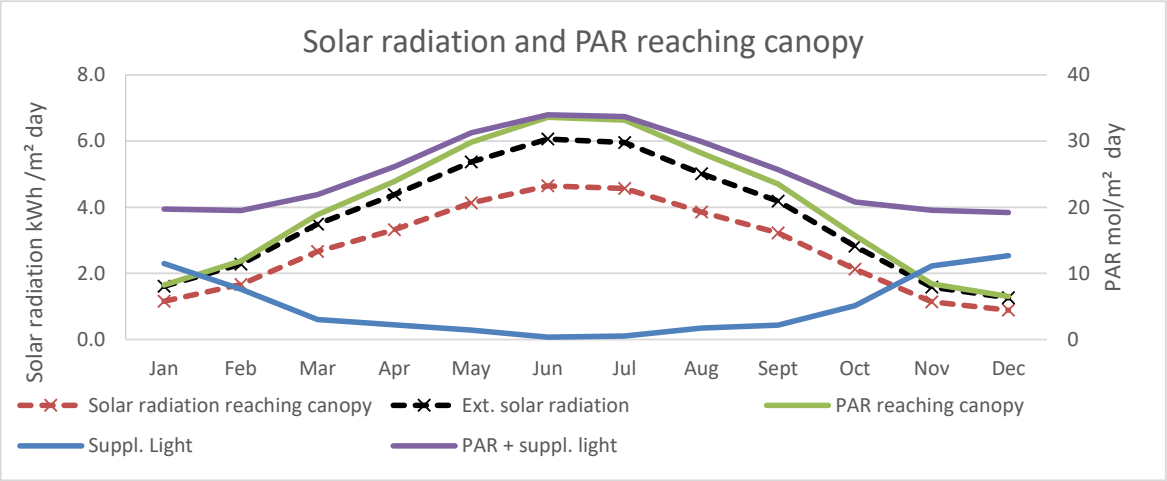
	Demand kWh	TOTAL kWh	Main kWh	Second kWh	Auxiliary kWh
Jan	485 029	491 921	450 350	41 571	0
Feb	461 087	468 197	421 552	46 646	0
Mar	349 321	354 666	326 816	27 850	0
Apr	204 906	207 676	202 682	4 994	0
May	171 632	174 996	162 672	12 325	0
Jun	51 821	53 802	52 990	812	0
Jul	10 295	12 160	12 160	0	0
Aug	34 836	36 730	36 730	0	0
Sept	68 898	71 011	69 534	1 476	0
Oct	197 861	200 787	193 915	6 872	0
Nov	389 319	393 968	371 256	22 712	0
Dec	462 465	468 466	434 861	33 605	0
Total	**2 887 470**	**2 934 380**	**2 735 518**	**198 862**	**0**

3. Monthly heating expenditure



	TOTAL C$	Main C$	Second C$	Auxiliary C$
Jan	16 005	13 510	2 494	0
Feb	15 445	12 647	2 799	0
Mar	11 475	9 804	1 671	0
Apr	6 380	6 080	300	0
May	5 620	4 880	739	0
Jun	1 638	1 590	49	0
Jul	365	365	0	0
Aug	1 102	1 102	0	0
Sept	2 175	2 086	89	0
Oct	6 230	5 817	412	0
Nov	12 500	11 138	1 363	0
Dec	15 062	13 046	2 016	0
Total	**93 997**	**82 066**	**11 932**	**0**

4. Solar radiation and PAR reaching canopy

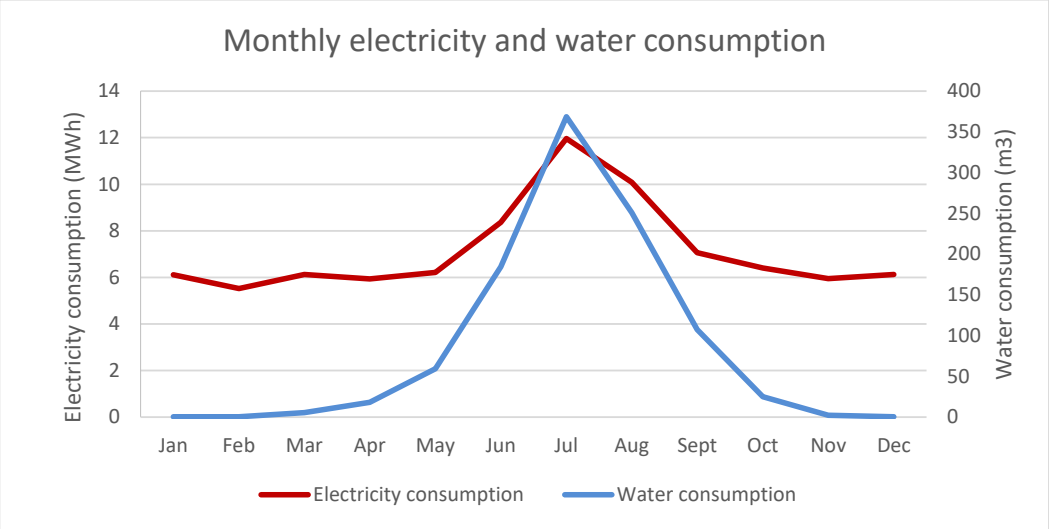


	External	Internal reaching canopy			
	Ext. solar radiation	Solar radiation	PAR	Suppl. Light	PAR + suppl. light
	kWh/ m² day	kWh/ m² day	mol/m² day	mol/m² day	mol/m² day
Jan	1.61	1.16	8.24	11.49	19.71
Feb	2.28	1.67	11.87	7.61	19.49
Mar	3.49	2.66	18.89	3.03	21.90
Apr	4.38	3.32	23.89	2.24	26.12
May	5.37	4.14	29.83	1.43	31.26
Jun	6.06	4.65	33.60	0.36	33.98
Jul	5.96	4.57	33.19	0.52	33.72
Aug	5.01	3.86	28.18	1.74	29.92
Sept	4.18	3.22	23.51	2.17	25.68
Oct	2.82	2.13	15.70	5.10	20.79
Nov	1.59	1.14	8.43	11.11	19.55
Dec	1.26	0.89	6.52	12.68	19.20
Average	**3.67**	**2.78**	**20.16**	**4.96**	**25.11**

5. Pad & wall, fog and cooling systems

5.1 Pad & wall and semi-closed

Electricity	
Electricity (C$/MWh)	90
Energy (MWh)	85.9
kWh/m²	8.9
Expenditure (C$)	7 727
C$ /m²	0.80



	Electricity		Water in pad	
	MWh	kWh/m²	m^3	l/m²
Jan	6.1	0.6	0	0.0
Feb	5.5	0.6	0	0.0
Mar	6.1	0.6	5	0.6
Apr	5.9	0.6	18	1.9
May	6.2	0.6	59	6.2
Jun	8.4	0.9	184	19.2
Jul	12.0	1.2	369	38.4
Aug	10.1	1.1	251	26.1
Sept	7.1	0.7	107	11.2
Oct	6.4	0.7	25	2.6
Nov	5.9	0.6	2	0.2
Dec	6.1	0.6	1	0.1
Total	**85.9**	**8.9**	**1 023**	106.5

Semi-closed greenhouse:

	Latent dehumidification for heating	Sensible heating	Latent dehumidification for heating	Sensible heating
	kWh	kWh	kWh/m²	kW/m²
Jan	0	485 029	0	51
Feb	2	461 085	0	48
Mar	61	349 260	0	36
Apr	141	204 765	0	21
May	682	170 951	0	18
Jun	736	51 085	0	5
Jul	443	9 852	0	1
Aug	1 109	33 727	0	4
Sept	1 044	67 854	0	7
Oct	447	197 415	0	21
Nov	68	389 251	0	41
Dec	34	462 431	0	48
Total	**4 765**	**2 882 704**	**0**	**300**

5.2 Closed greenhouse: estimation for sensible and latent needs

	Cooling needs (sensible)	Cooling needs (Latent)	Cooling needs (Total)	
	MWh	MWh	MWh	kWh/m²
Jan	-	-	-	-
Feb	-	-	-	-
Mar	-	-	-	-
Apr	-	-	-	-
May	-	-	-	-
Jun	-	-	-	-
Jul	-	-	-	-
Aug	-	-	-	-
Sept	-	-	-	-
Oct	-	-	-	-
Nov	-	-	-	-
Dec	-	-	-	-
Total	**-**	**-**	**-**	**-**

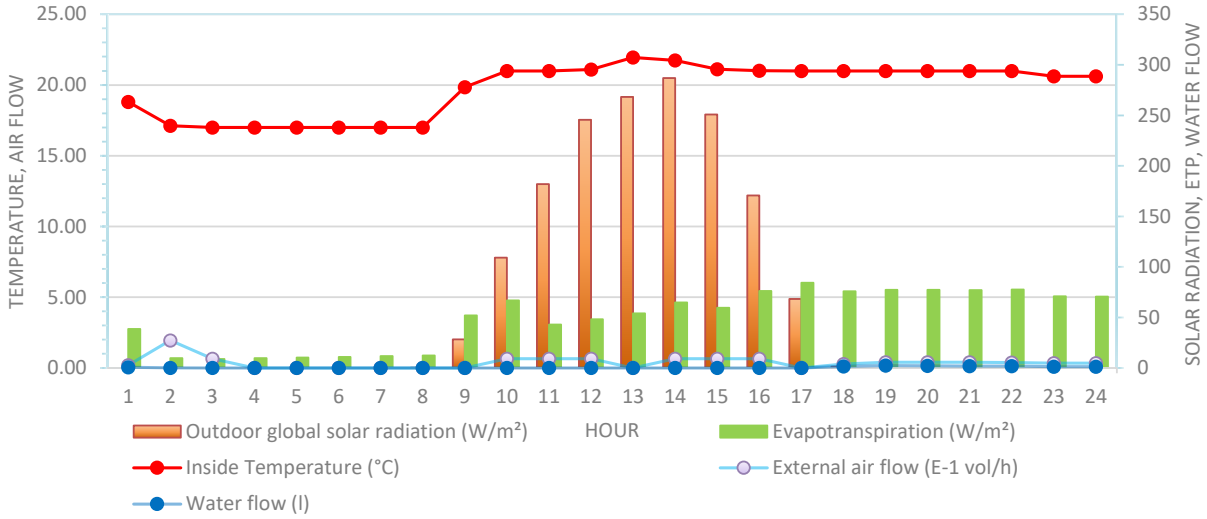
6. Supplemental lighting

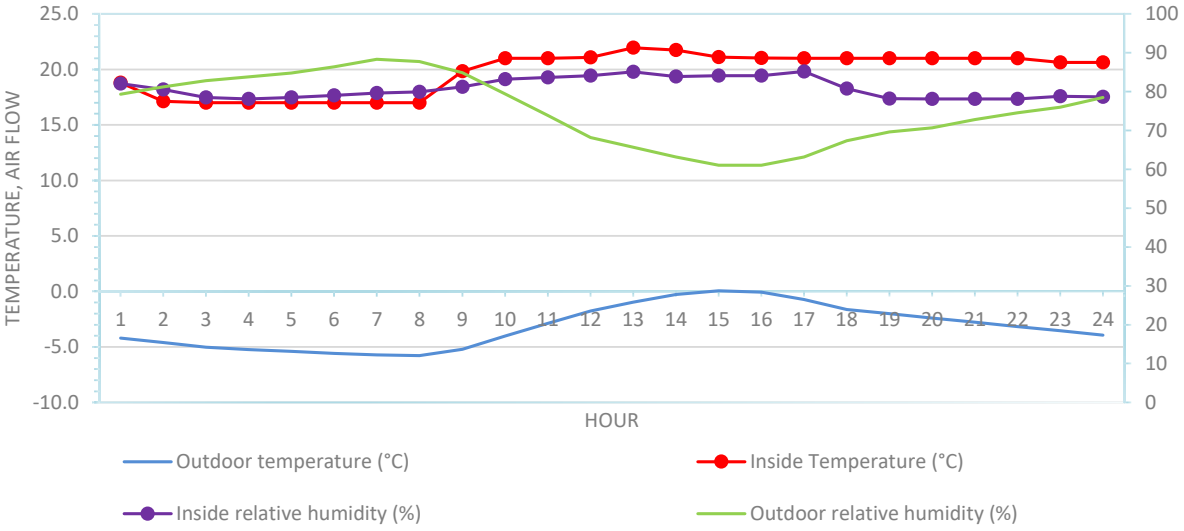
	Electricity consumption		Expenditure	
	MWh	kWh/m²	C$	C$/m²
Jan	326.4	34.0	29 376.0	3.1
Feb	206.4	21.5	18 576.0	1.9
Mar	92.2	9.6	8 294.4	0.9
Apr	62.4	6.5	5 616.0	0.6
May	44.2	4.6	3 974.4	0.4
Jun	11.5	1.2	1 036.8	0.1
Jul	14.4	1.5	1 296.0	0.1
Aug	50.9	5.3	4 579.2	0.5
Sept	64.3	6.7	5 788.8	0.6
Oct	147.8	15.4	13 305.6	1.4
Nov	299.5	31.2	26 956.8	2.8
Dec	363.8	37.9	32 745.6	3.4
Total	**1 683.8**	**175.4**	**151 545.6**	**15.8**

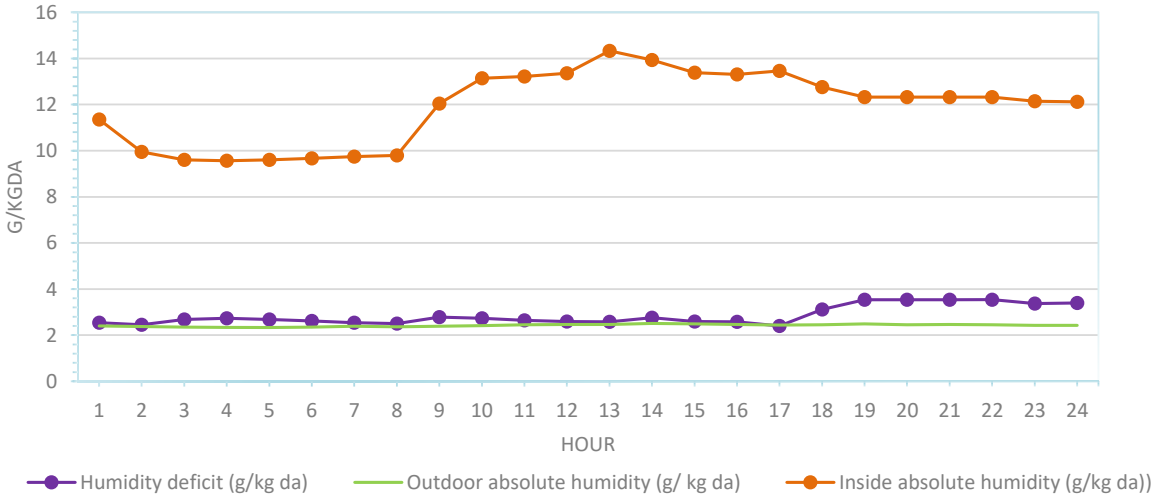
	Sensible heat generated		Latent heat generated	
	MWh	kWh/m²	MWh	kWh/m²
Jan	97.9	10.2	228.5	23.8
Feb	61.9	6.5	144.5	15.1
Mar	27.6	2.9	64.5	6.7
Apr	18.7	2.0	43.7	4.6
May	13.2	1.4	30.9	3.2
Jun	3.5	0.4	8.1	0.8
Jul	4.3	0.5	10.1	1.1
Aug	15.3	1.6	35.6	3.7
Sept	19.3	2.0	45.0	4.7
Oct	44.4	4.6	103.5	10.8
Nov	89.9	9.4	209.7	21.8
Dec	109.2	11.4	254.7	26.5
Total	**505.2**	**52.6**	**1 178.7**	**122.8**

7. Inner climate

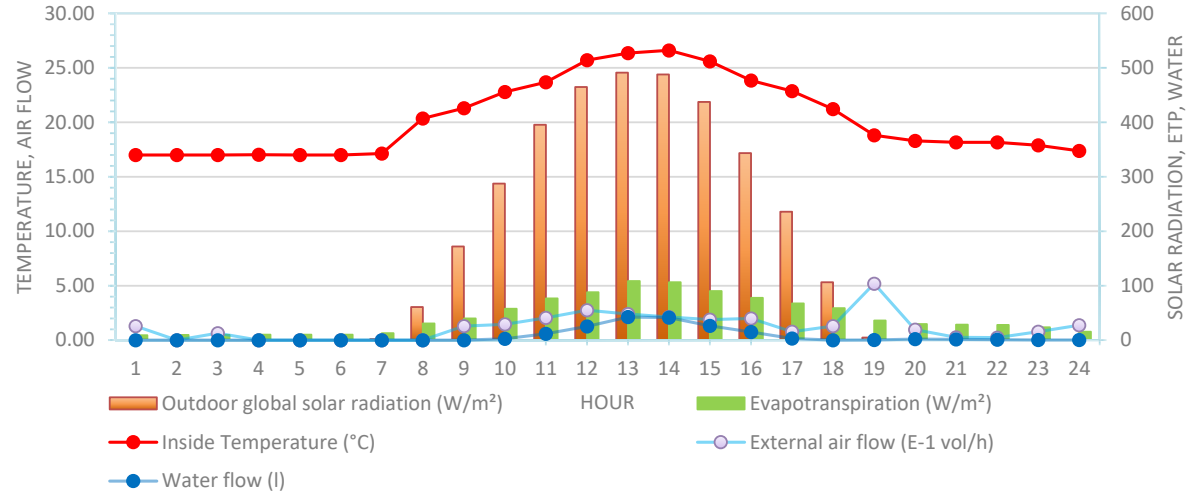
A. Inner climate for an average day in January

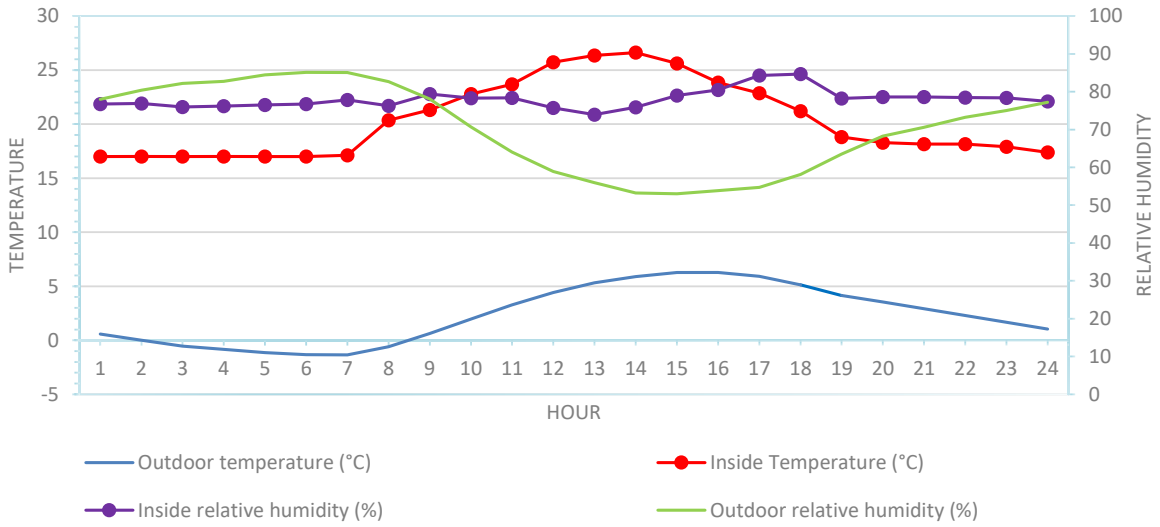


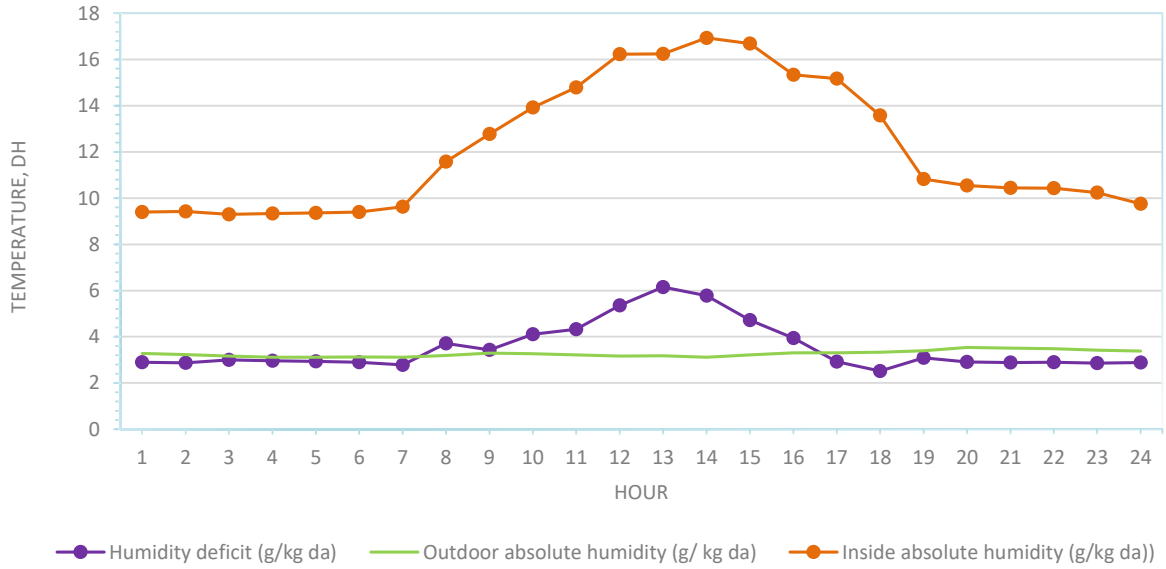




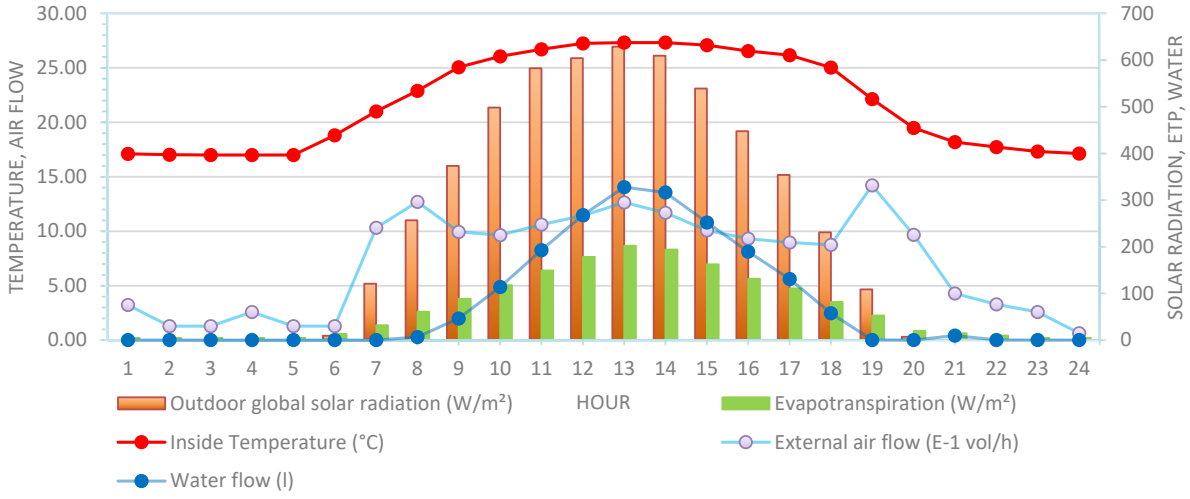
B. Inner climate for an average day in March

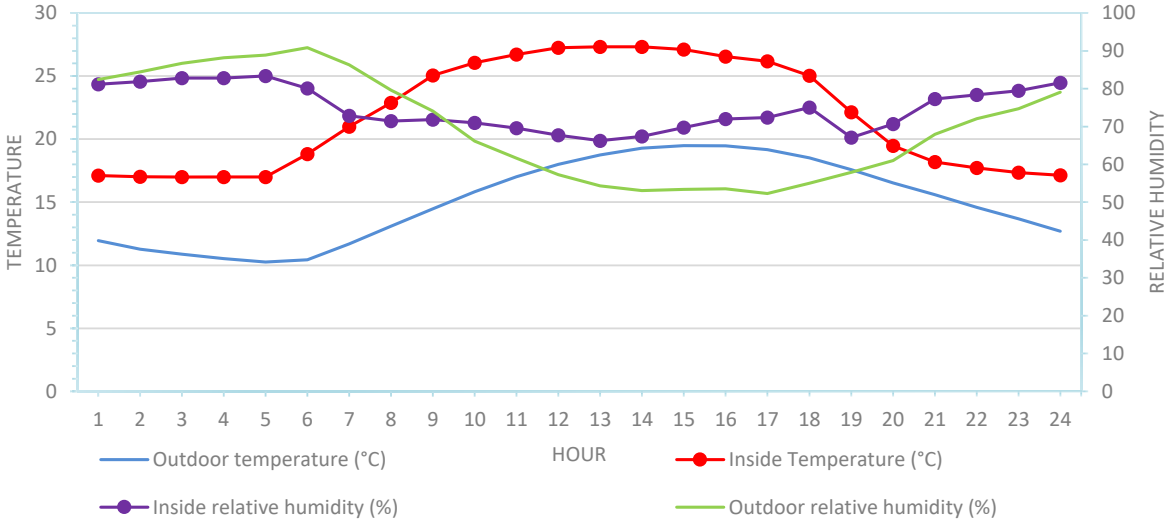


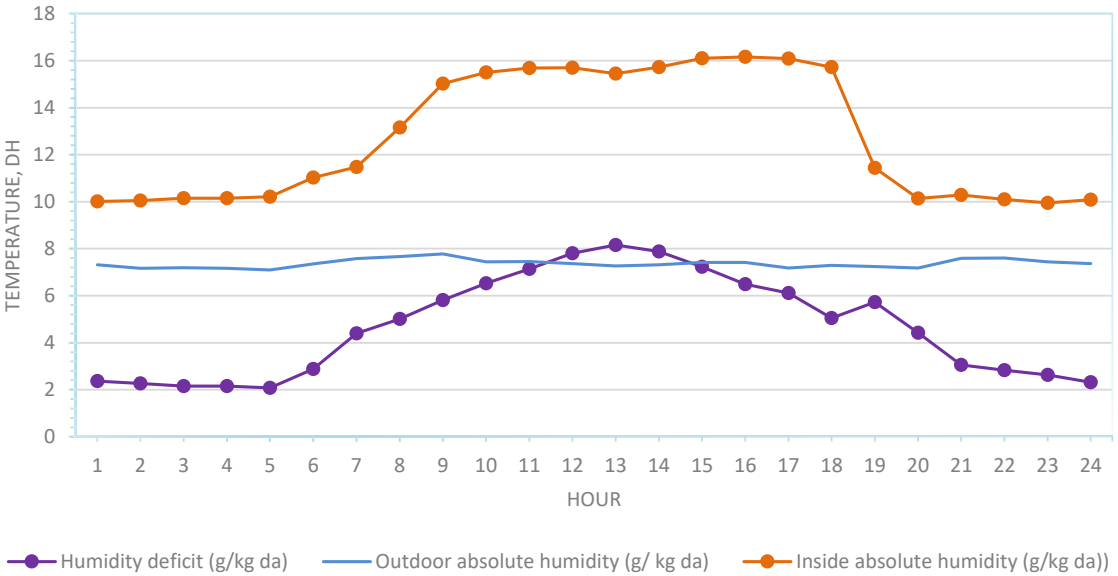




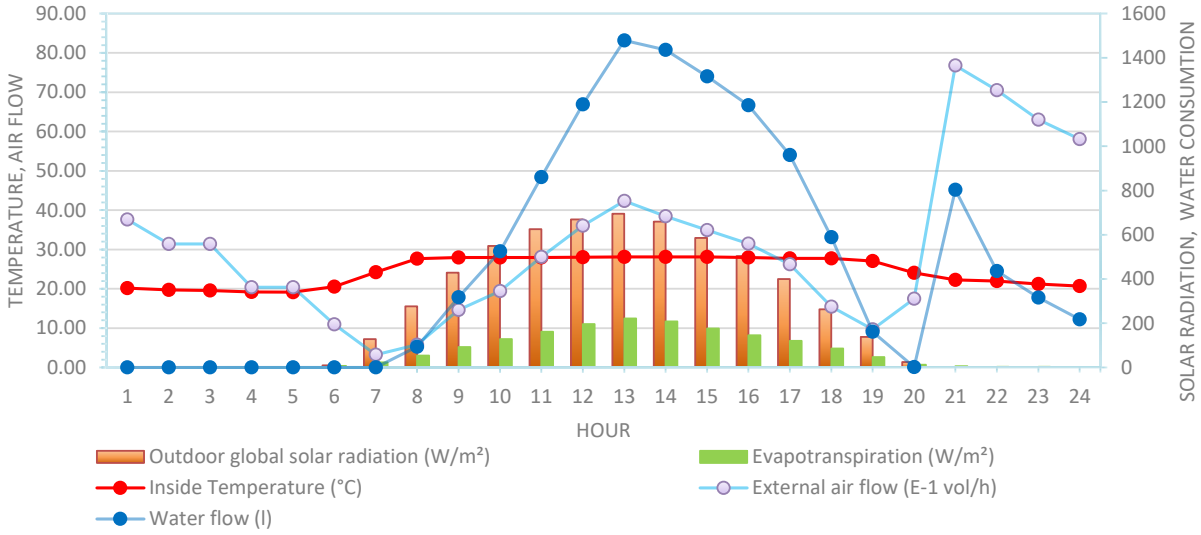
C. Inner climate for an average day in May

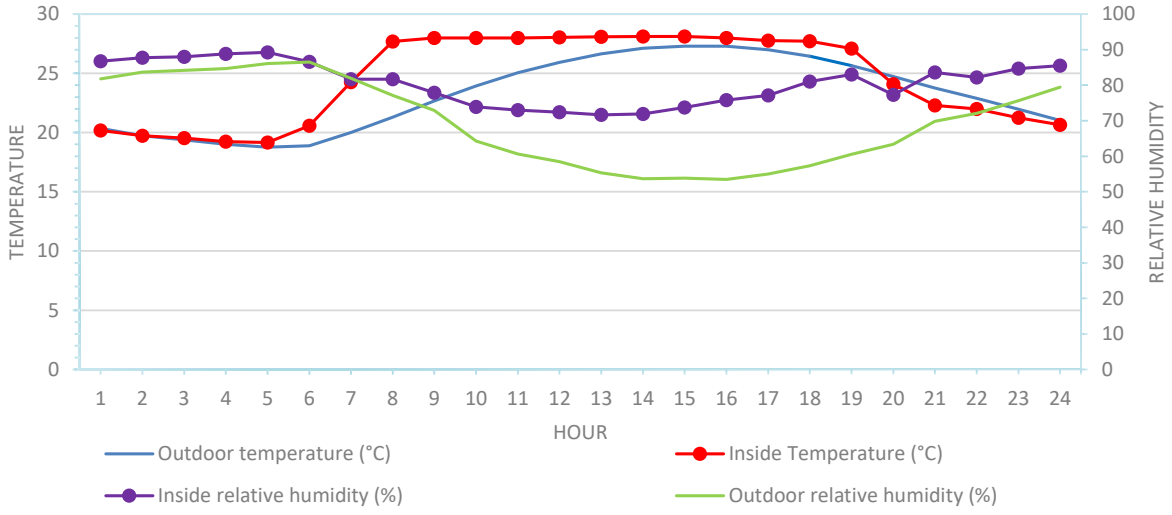


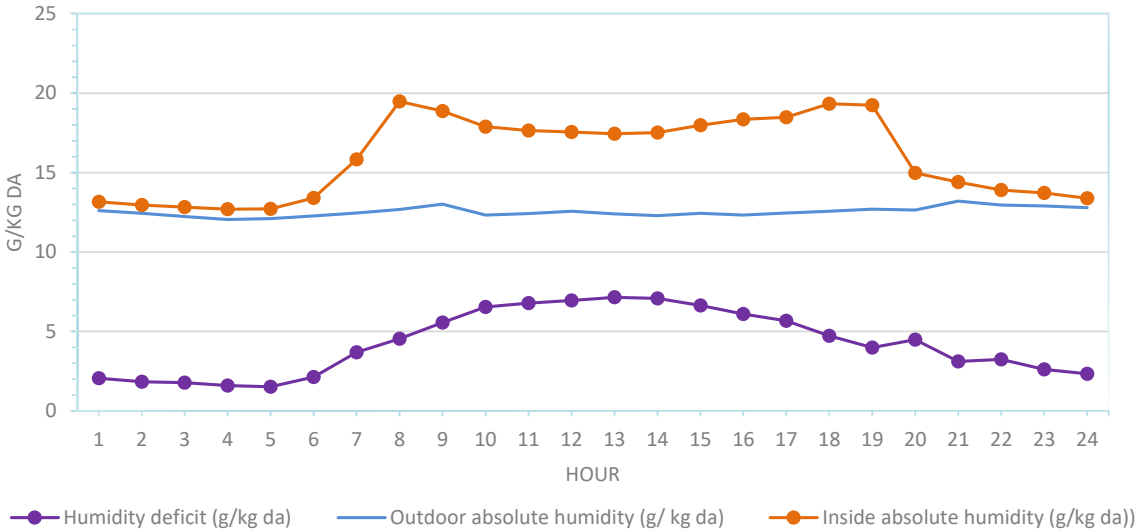




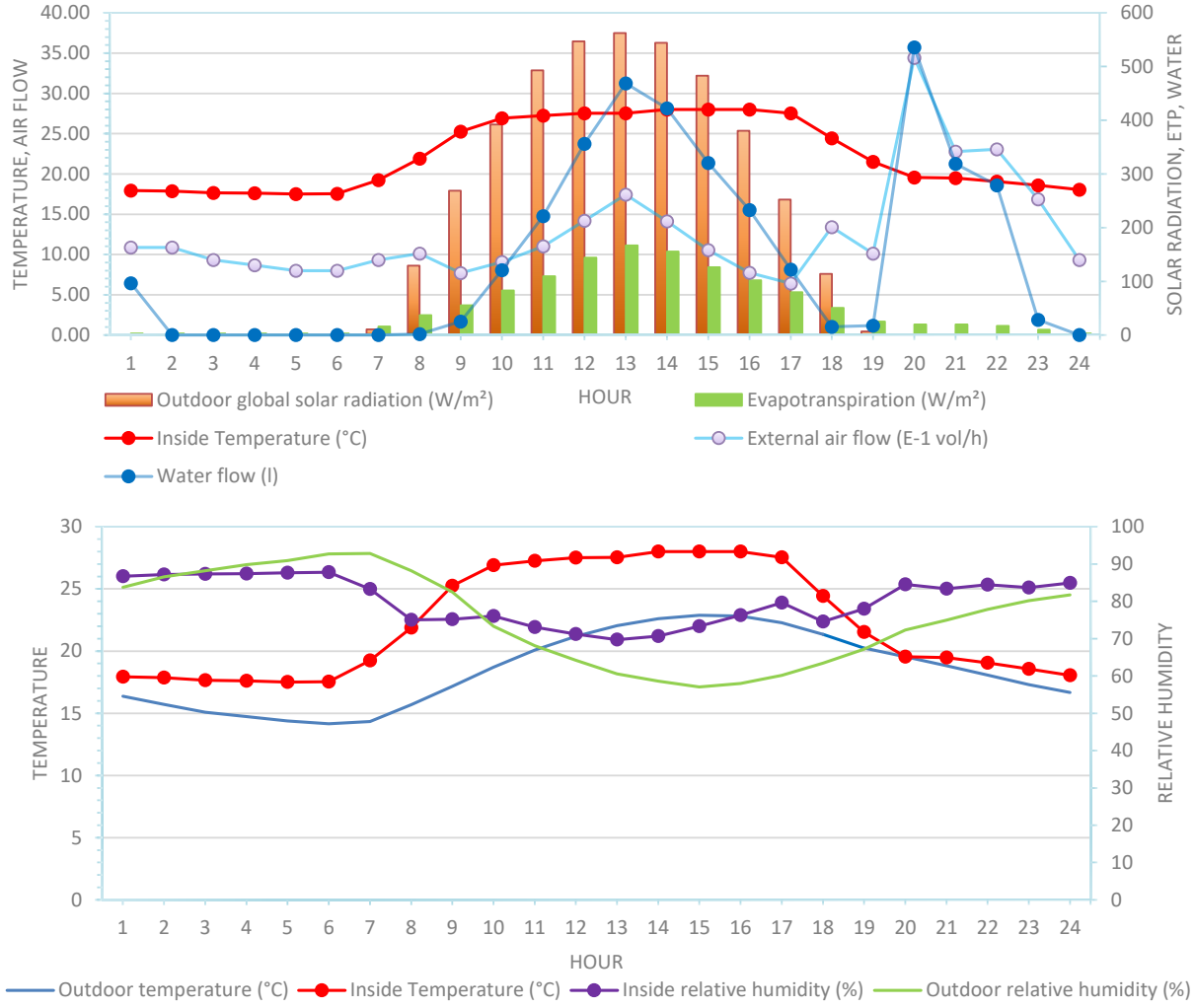
D. Inner climate for an average day in July

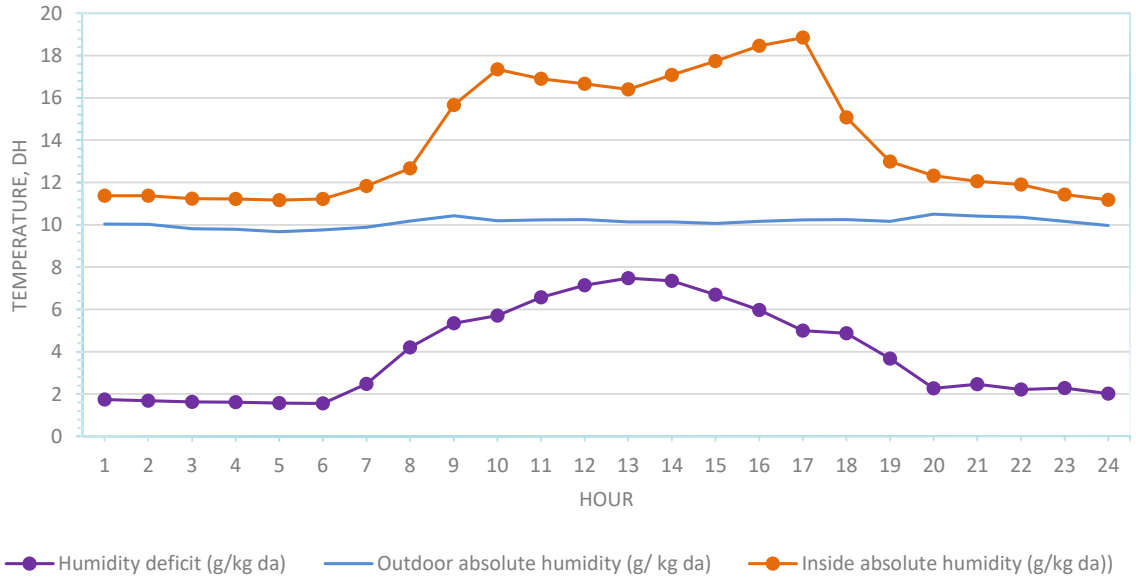




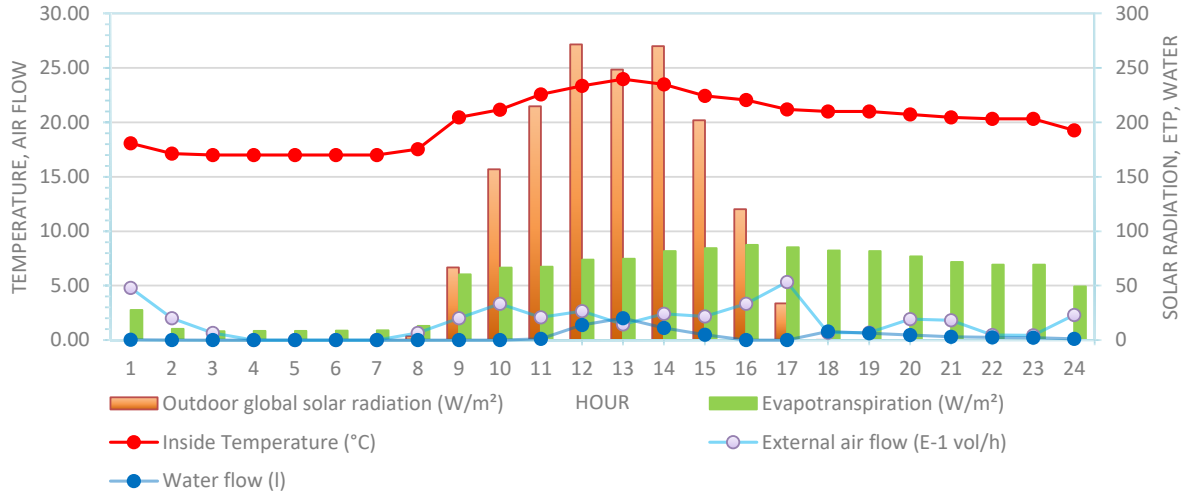


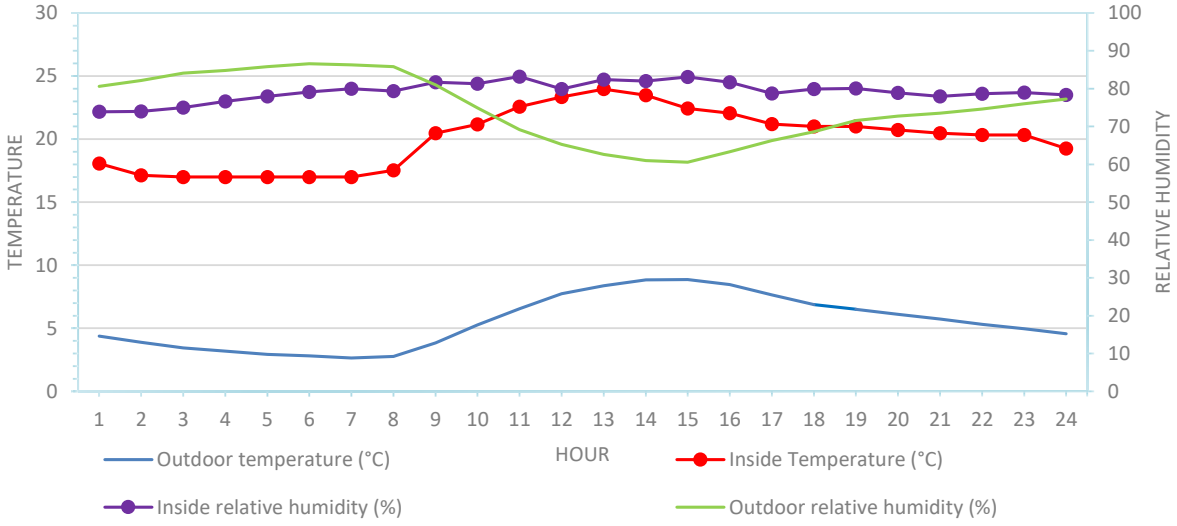
E. Inner climate for a typical day in September

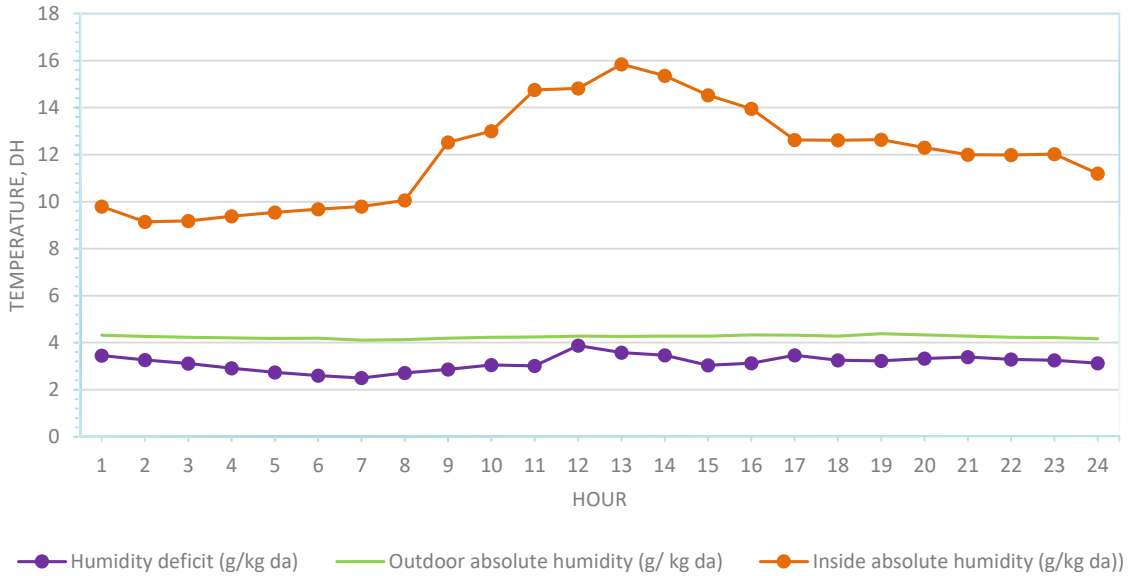




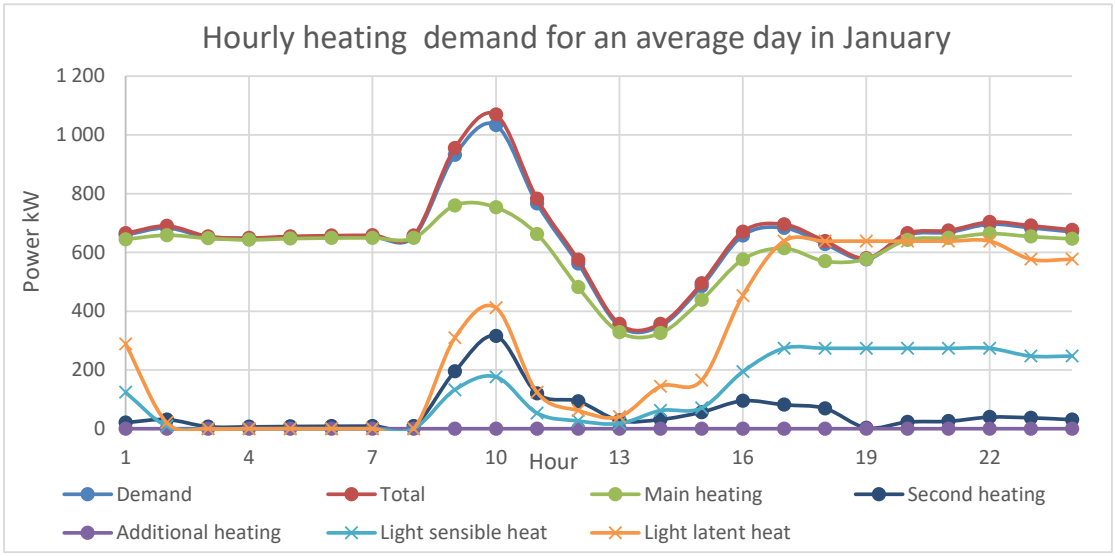
F. Inner climate for an average day in November

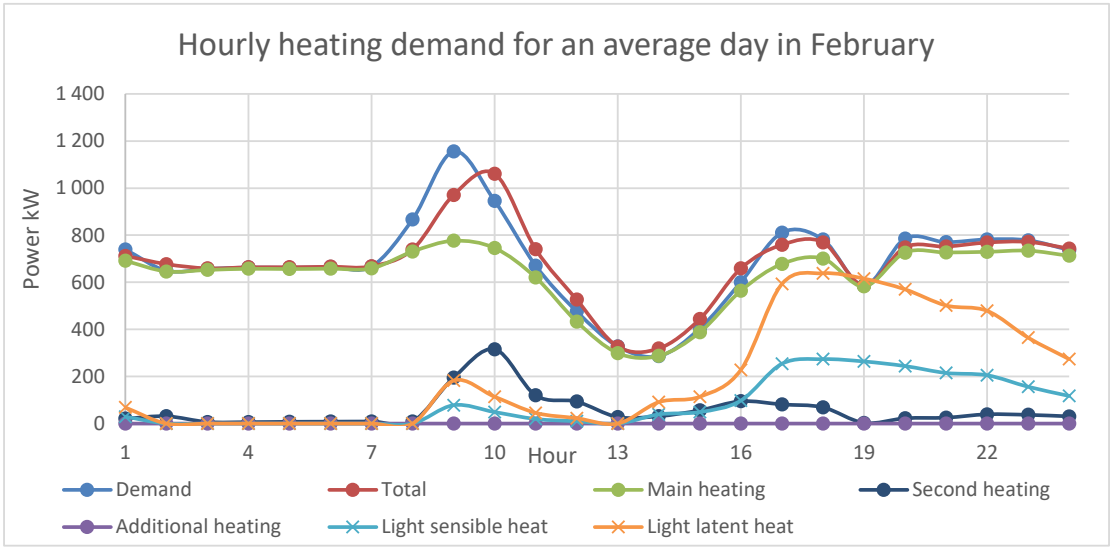


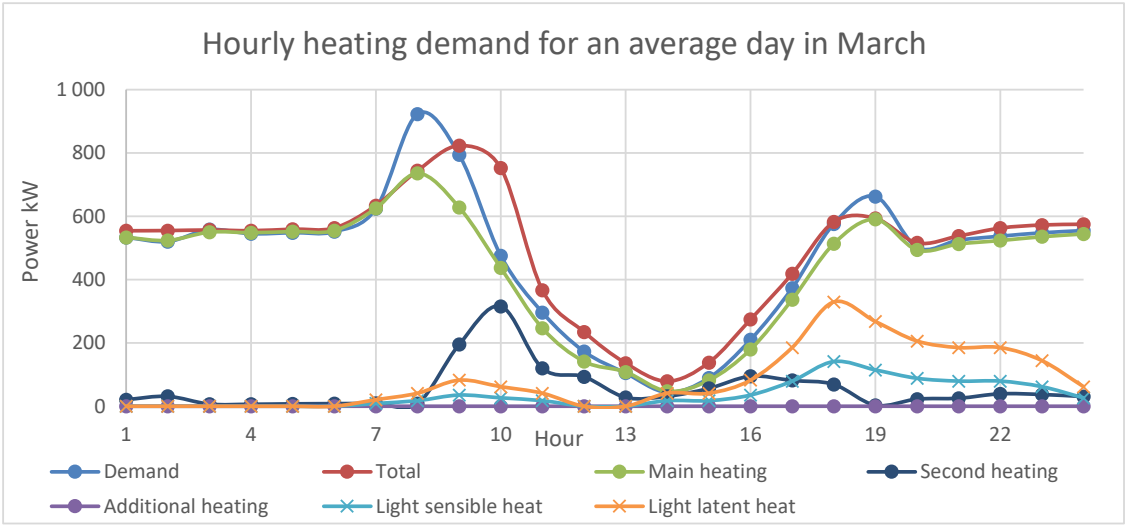


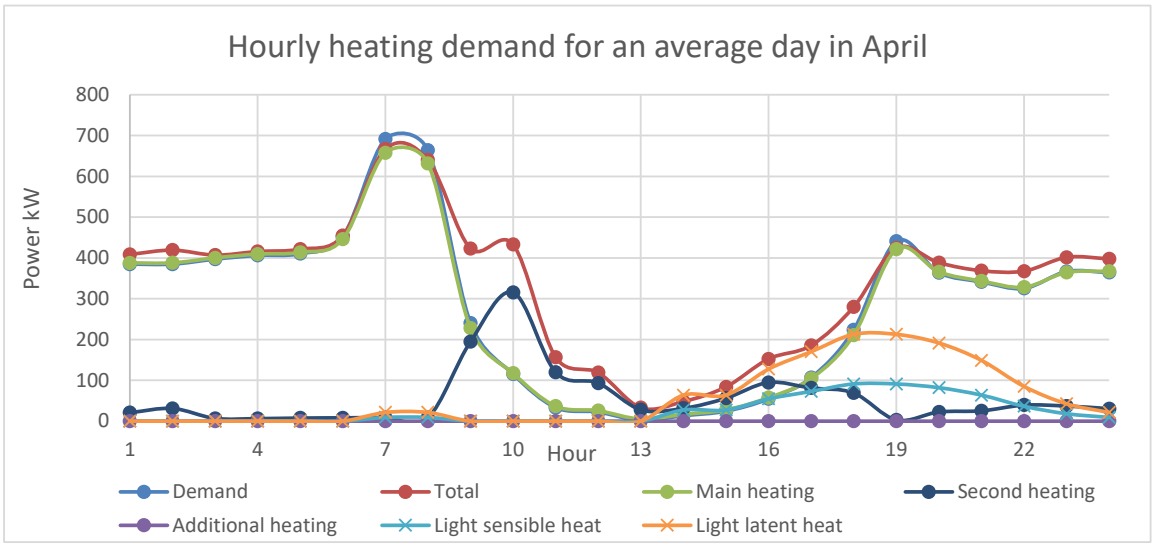


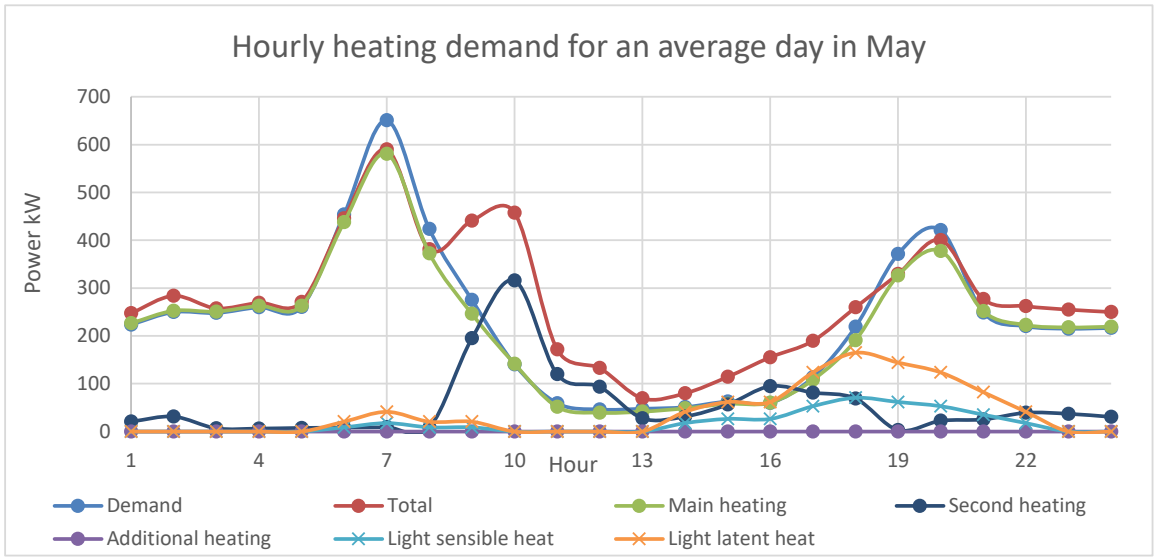
10. Daily heating energy consumption

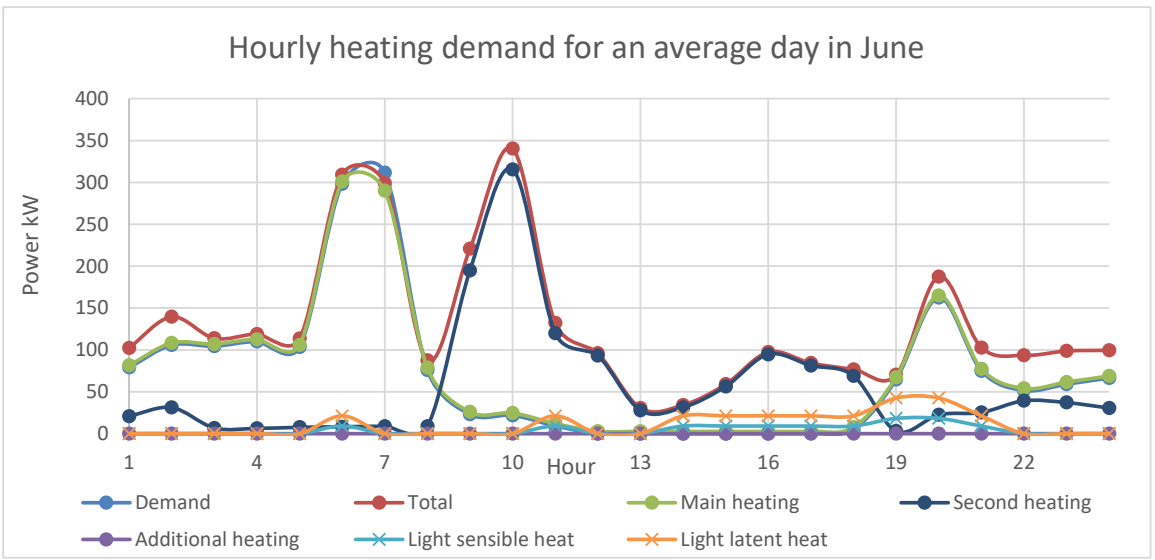


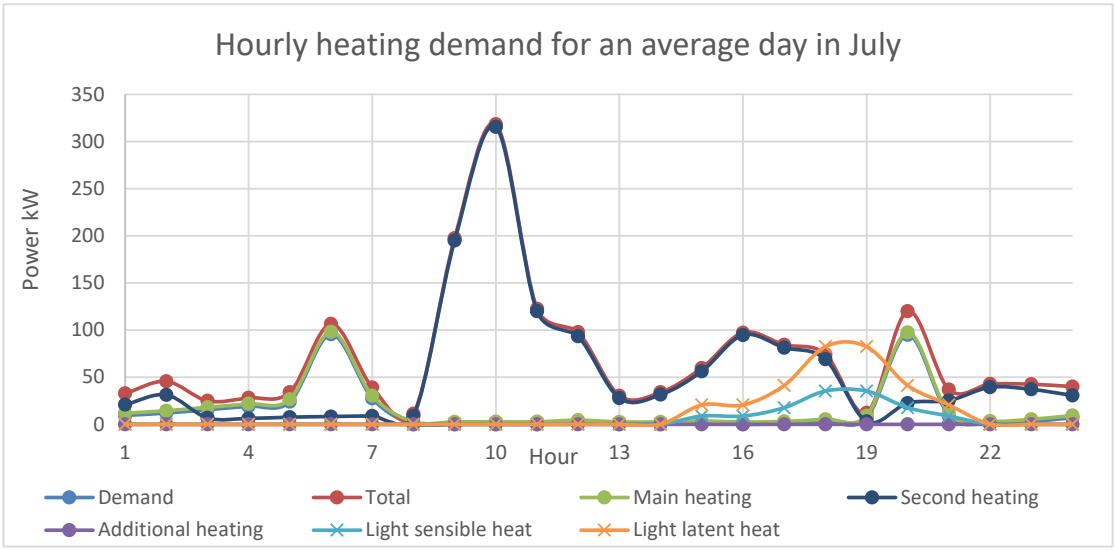


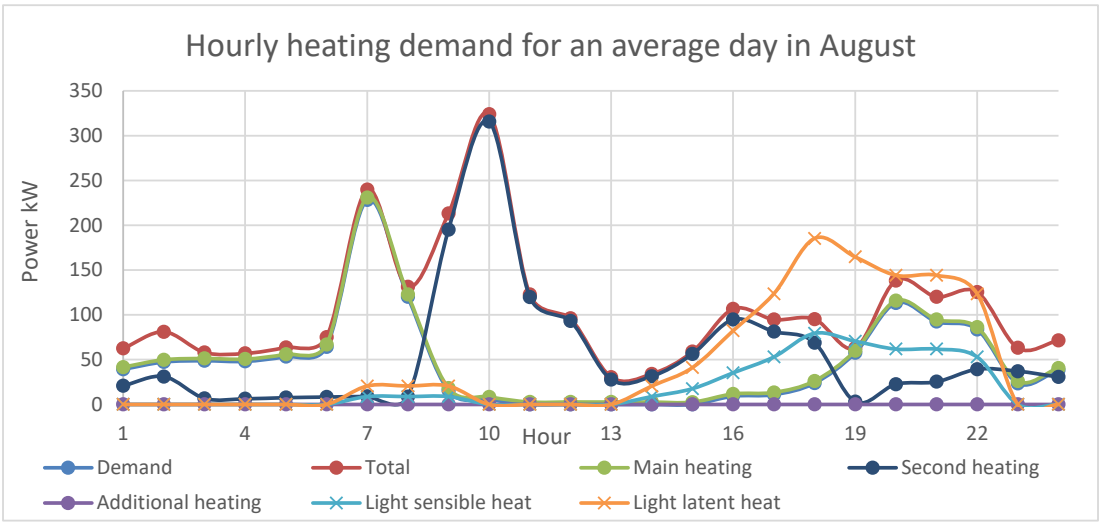


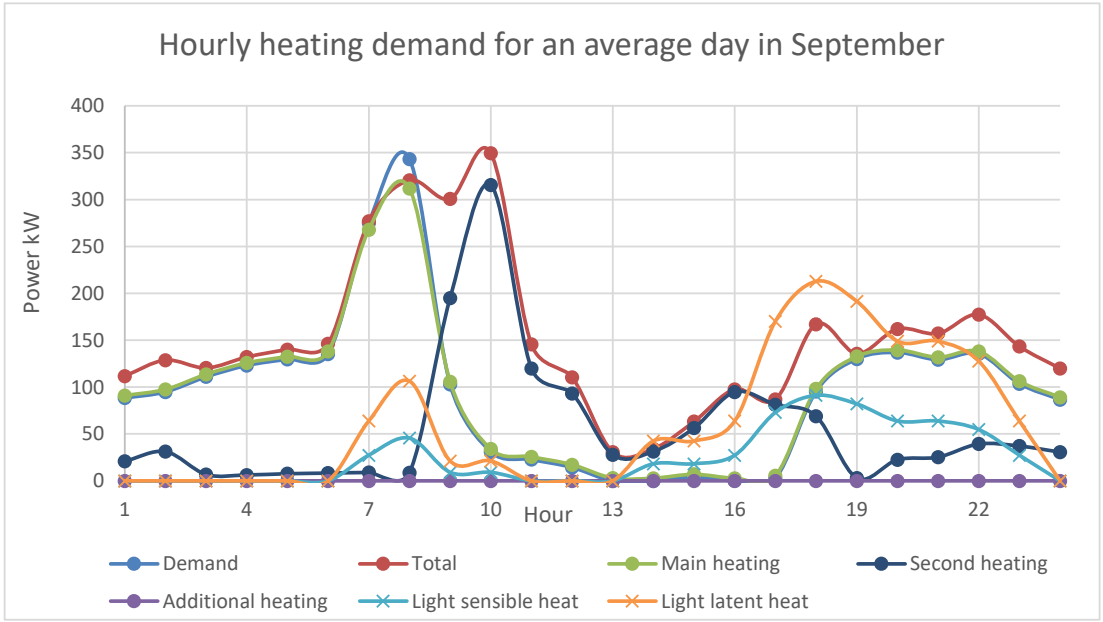

Hourly heating demand for an average day in April
Power kW
800
700
600
500
400
300
200
100
0
1
4
7
10
Hour
13
16
19
22
Demand
Total
Main heating
Second heating
Additional heating
Light sensible heat
Light latent heat

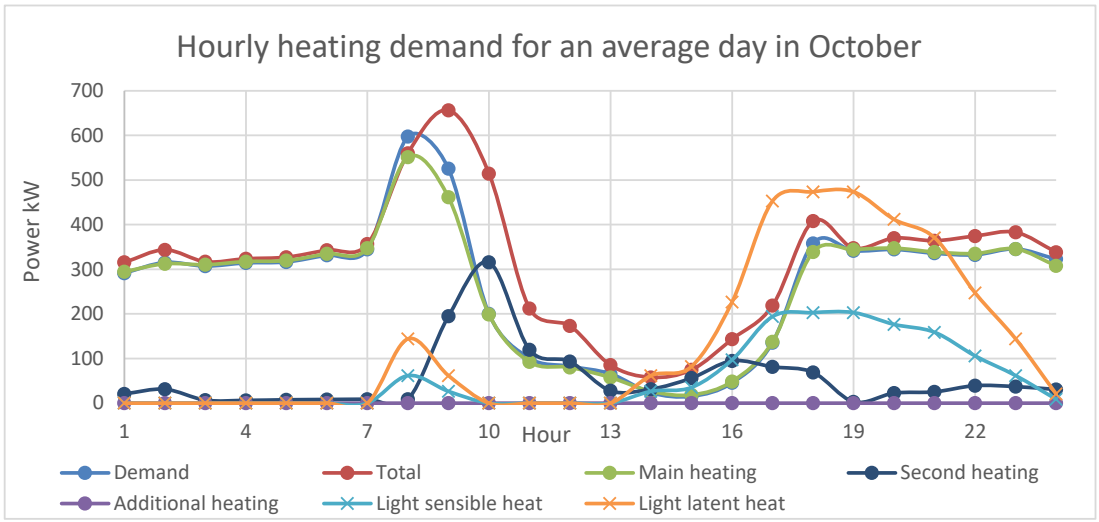

Hourly heating demand for an average day in May
Power kW
700
600
500
400
300
200
100
0
1
4
7
10
Hour
13
16
19
22
Demand
Total
Main heating
Second heating
Additional heating
Light sensible heat
Light latent heat

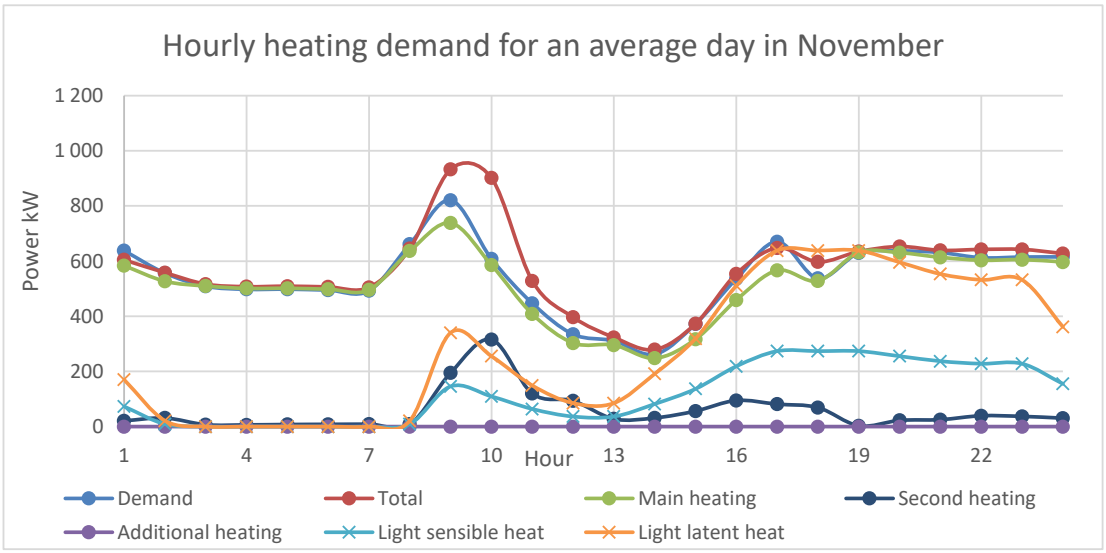

Hourly heating demand for an average day in June
Power kW
400
350
300
250
200
150
100
50
0
1
4
7
10
Hour
13
16
19
22
Demand
Total
Main heating
Second heating
Additional heating
Light sensible heat
Light latent heat

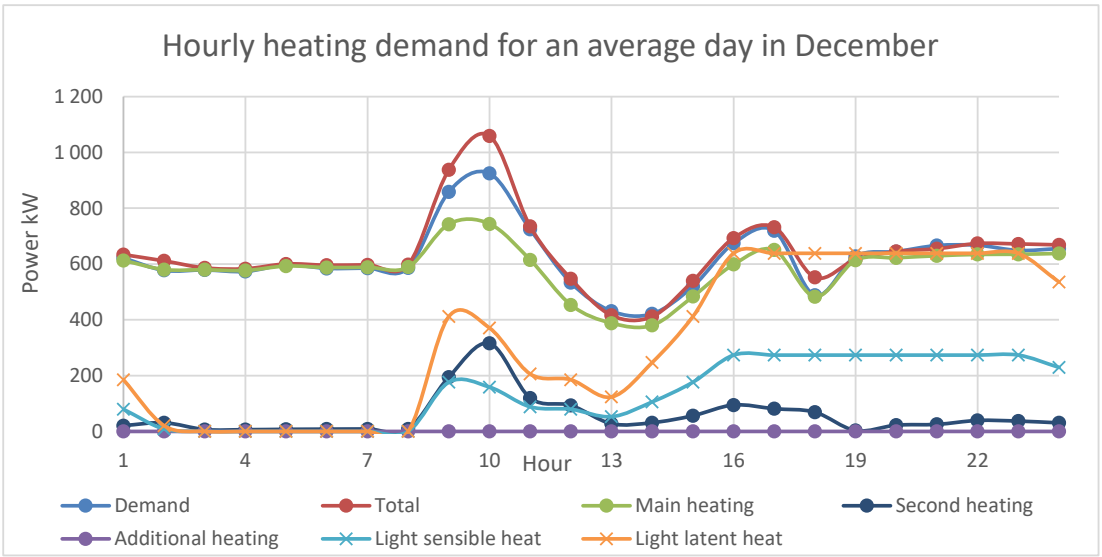

Hourly heating demand for an average day in July
Power kW
350
300
250
200
150
100
50
0
1
4
7
10
Hour
13
16
19
22
Demand
Total
Main heating
Second heating
Additional heating
Light sensible heat
Light latent heat


Hourly heating demand for an average day in August
Power kW
350
300
250
200
150
100
50
0
1
4
7
10
Hour
13
16
19
22
Demand
Total
Main heating
Second heating
Additional heating
Light sensible heat
Light latent heat

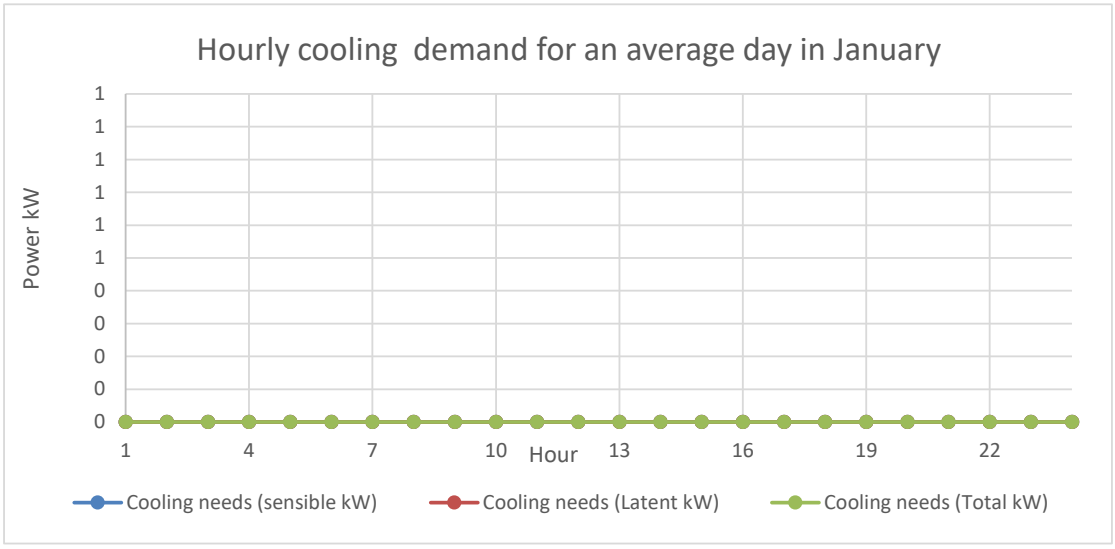

Hourly heating demand for an average day in September
Power kW
400
350
300
250
200
150
100
50
0
1
4
7
10
Hour
13
16
19
22
Demand
Total
Main heating
Second heating
Additional heating
Light sensible heat
Light latent heat

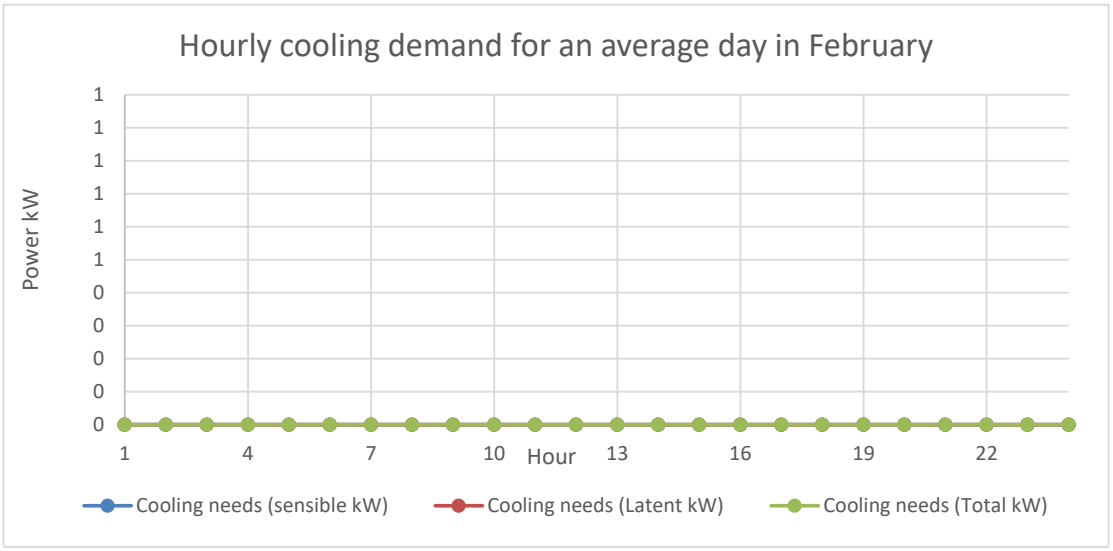

Hourly heating demand for an average day in October
Power kW
700
600
500
400
300
200
100
0
1
4
7
10
Hour
13
16
19
22
Demand
Total
Main heating
Second heating
Additional heating
Light sensible heat
Light latent heat

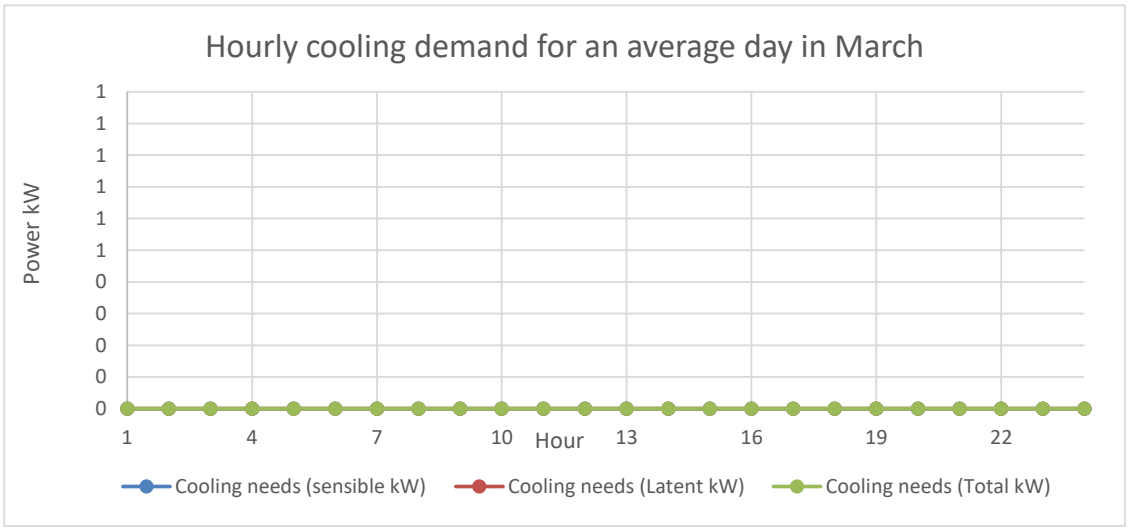

Hourly heating demand for an average day in November
Power kW
1 200
1 000
800
600
400
200
0
1
4
7
10
Hour
13
16
19
22
Demand
Total
Main heating
Second heating
Additional heating
Light sensible heat
Light latent heat

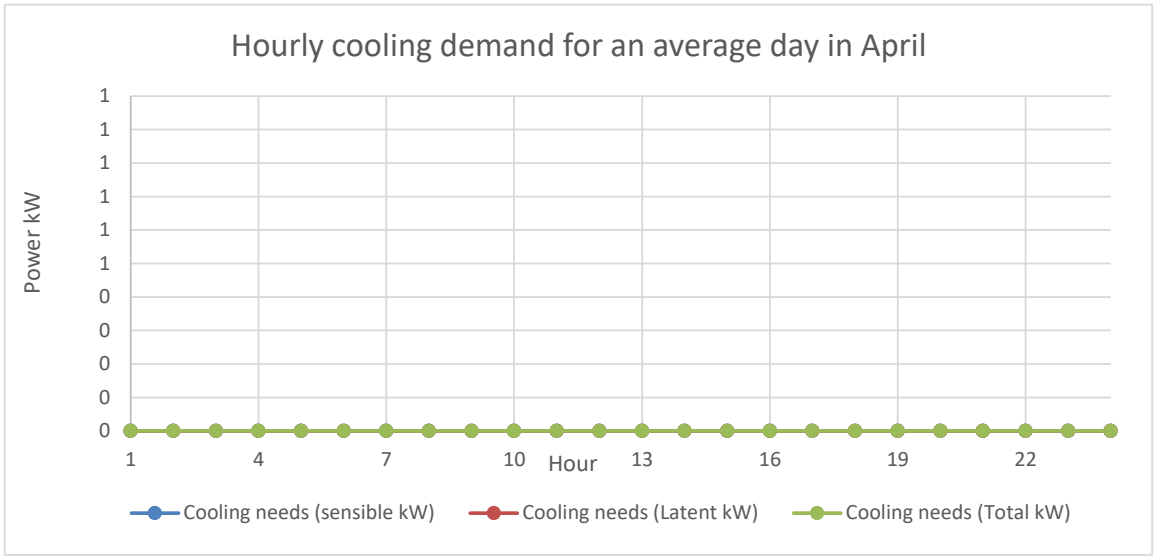

Hourly heating demand for an average day in December
Power kW
1 200
1 000
800
600
400
200
0
1
4
7
10
Hour
13
16
19
22
Demand
Total
Main heating
Second heating
Additional heating
Light sensible heat
Light latent heat

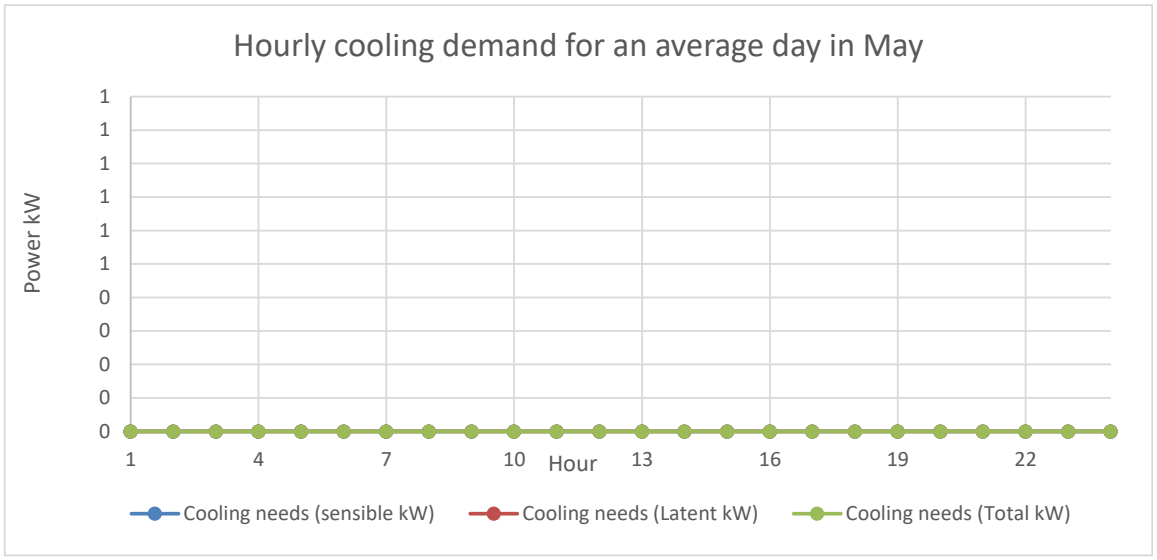
11. Daily cooling energy demand in closed greenhouse

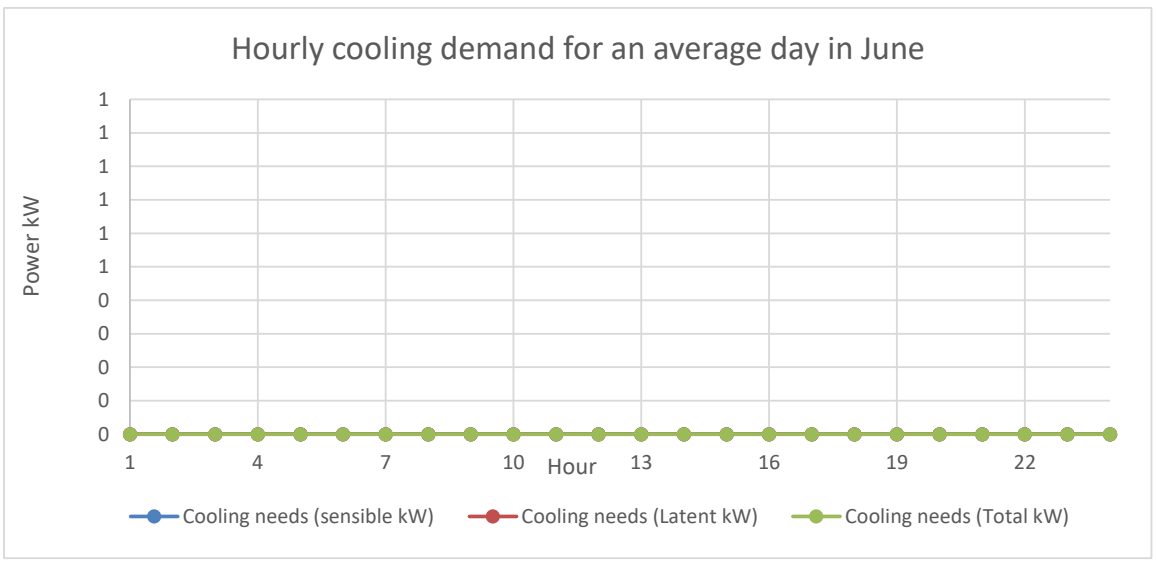


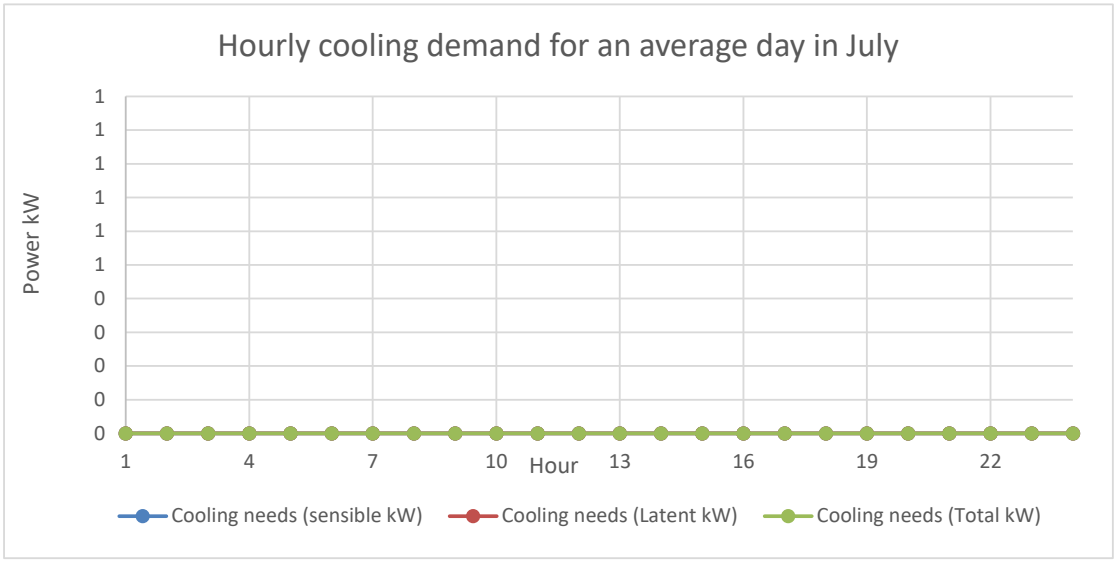


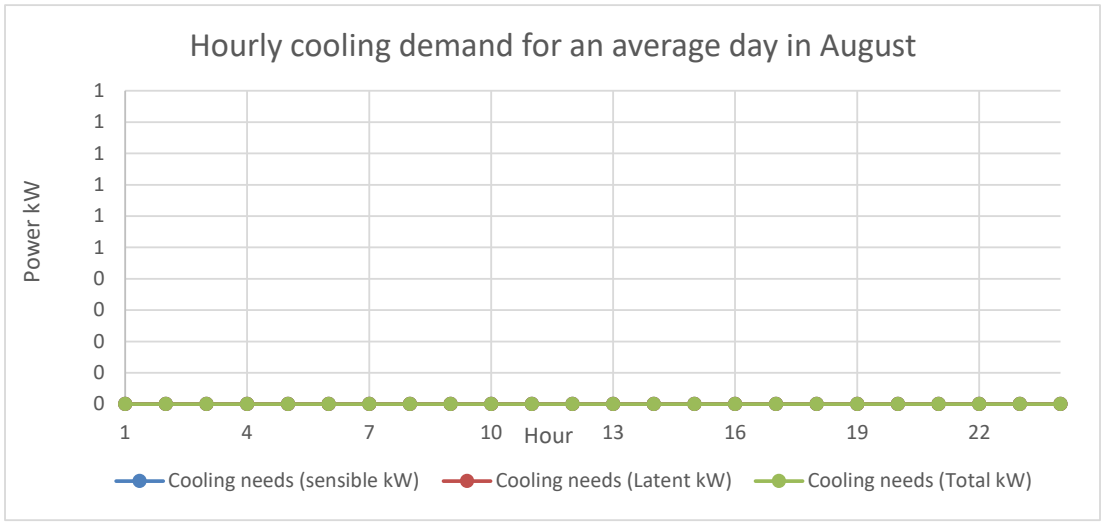


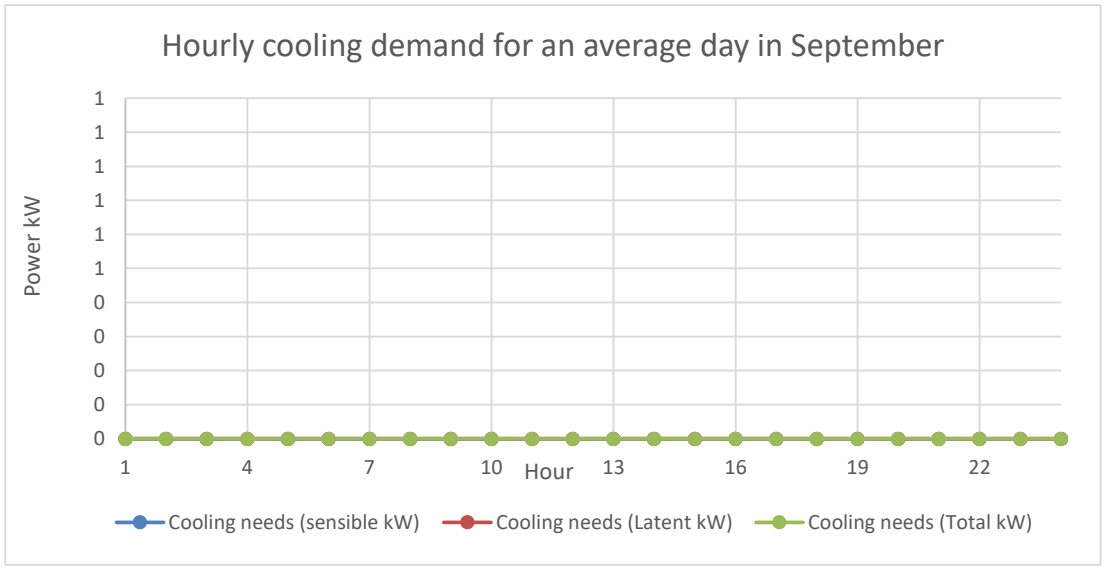

Hourly cooling demand for an average day in April
Power kW
1
1
1
1
1
1
0
0
0
0
0
1
4
7
10
13
16
19
22
Hour
Cooling needs (sensible kW)
Cooling needs (Latent kW)
Cooling needs (Total kW)


Hourly cooling demand for an average day in May
Power kW
1
1
1
1
1
1
0
0
0
0
0
1
4
7
10
13
16
19
22
Hour
Cooling needs (sensible kW)
Cooling needs (Latent kW)
Cooling needs (Total kW)


Hourly cooling demand for an average day in June
Power kW
1
1
1
1
1
1
0
0
0
0
0
1
4
7
10
13
16
19
22
Hour
Cooling needs (sensible kW)
Cooling needs (Latent kW)
Cooling needs (Total kW)


Hourly cooling demand for an average day in July
Power kW
1
1
1
1
1
1
0
0
0
0
0
1
4
7
10
Hour
13
16
19
22
Cooling needs (sensible kW)
Cooling needs (Latent kW)
Cooling needs (Total kW)


Hourly cooling demand for an average day in August
Power kW
1
1
1
1
1
1
0
0
0
0
0
1
4
7
10
Hour
13
16
19
22
Cooling needs (sensible kW)
Cooling needs (Latent kW)
Cooling needs (Total kW)


Hourly cooling demand for an average day in September
Power kW
1
1
1
1
1
1
0
0
0
0
0
1
4
7
10
Hour
13
16
19
22
Cooling needs (sensible kW)
Cooling needs (Latent kW)
Cooling needs (Total kW)