Hortinergy
Energy analysis for greenhouse project

Project name : Brest2

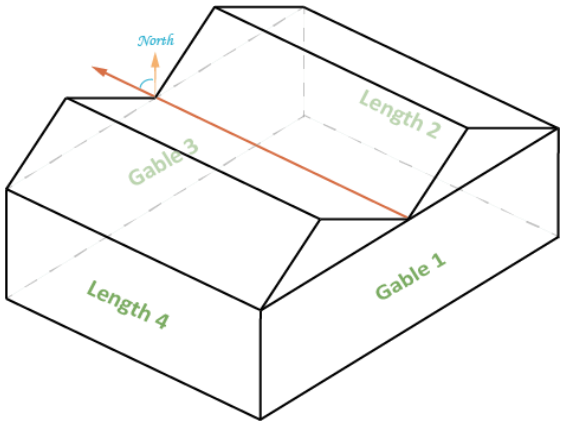
Date: 31/05/2018

Scenario :	Referance Greentech
Site:	
Latitude [°] =	48.3903
Longitude [°] =	-4.486
Altitude [m] =	51

A. Project parameters

1. Greenhouse design

Length (m)	150
Span – chapel width (m)	9.6
Width (m)	144
Area (m²)	21 600
Roof height (m)	7.8
Gutter height (m)	7
Greenhouse type	saw tooth
Air leakage (vol/h)	0.2
Ground type	Classic
Path type	Concrete
Path ratio (%)	10
Cover transmission loss	0



	Roof	Gable 1	Length 2	Gable 3	Length 4
Cover	4mm clear glass	4mm clear glass	4mm clear glass	4mm clear glass	4mm clear glass
Frame percentage	10	10	10	10	10
Screen	1	no	no	no	no
Screen 1 type	Thermal	0	0	0	0
Shade %	13	0	0	0	0
Screen 2 type	0				
Shade %	0				

2. Crop production

Type of crop	Tomato
Cultivation starting date	2017-12-01
End of cultivation	2018-11-01
Seedling age	4 weeks at transplantation

3. Climate management

a. Period and temperature setting

	Temperature setting	
	day	night
Period 1		
2017-12-01	20	18
2018-11-01		
Periode 2		
2018-11-02	10	10
2018-11-30		
Period 3		
0000-00-00	0	0
0000-00-00		
Period 4		
0000-00-00	0	0
0000-00-00		
Period 5		
0000-00-00	0	0
0000-00-00		
Period 6		
0000-00-00	0	0
0000-00-00		

b. Day / Night switch - screen regulation

Regulation type	Delta Temperature inside/outside and Solar radiation
Minimum solar radiation	100 W/m²
Min Delta temperature in/out	0 °C

b. Morning revival

Morning revival	Yes
Solar radiation	100 W/m²
Temperature increase	1 °C/h

4. Heat production

Dimensionning User defined (advanced parameters)

Heating	Main	Auxiliary
Energy source	CHP - recovery heat	Gas
Unit price (€/MWh)	10	35
Maximum power	1000	4 000
Condensor	Yes	Yes
Max yield (%)	95	95

Main energy period	Start	End
Date	2017-12-01	2018-11-30

Distribution yield (%)	95

Buffer tank	Yes (advanced parameters)
Volume (m^3)	700
Height (m)	10
Insulation (cm)	20
Temperature differance	40 (°C) between heat production and emission

5. Outdoor climate

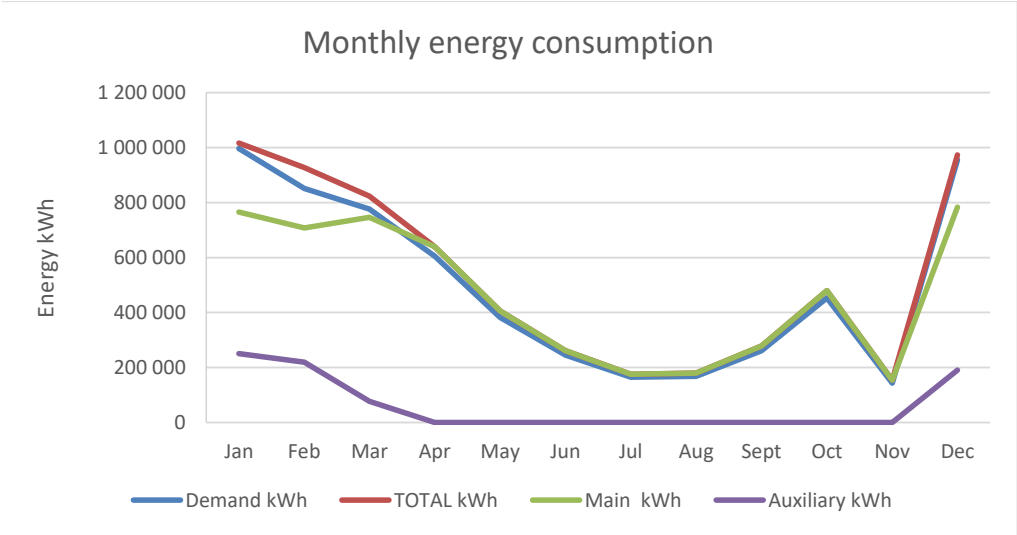
Month	Average outdoor temperature (°C)	Mimimum outdoor temperature (°C)	Maximum outdoor temperature (°C)	External average relative humidity (%)	External average global solar radiation (kWh/ m² day)
Januray	7.4	-2.8	14.1	86	0.87
February	7.3	-0.8	14.9	85	1.54
March	8.6	0.2	18.3	82	2.58
April	9.8	2.4	19.1	82	3.86
May	12.7	5.7	22.3	83	5.05
June	15.2	7.8	26.1	83	5.45
July	16.7	10.6	27.5	83	5.07
August	16.9	10.4	24.0	85	4.56
September	15.3	8.8	23.2	85	3.47
October	13.1	6.0	20.7	87	1.98
November	10.0	3.1	17.3	87	1.15
December	7.6	-1.3	14.9	85	0.75
Average/ Min /Max	11.7	-2.8	27.5	85	3.04

B. Energy consumption

1. Annual cost and energy consumption

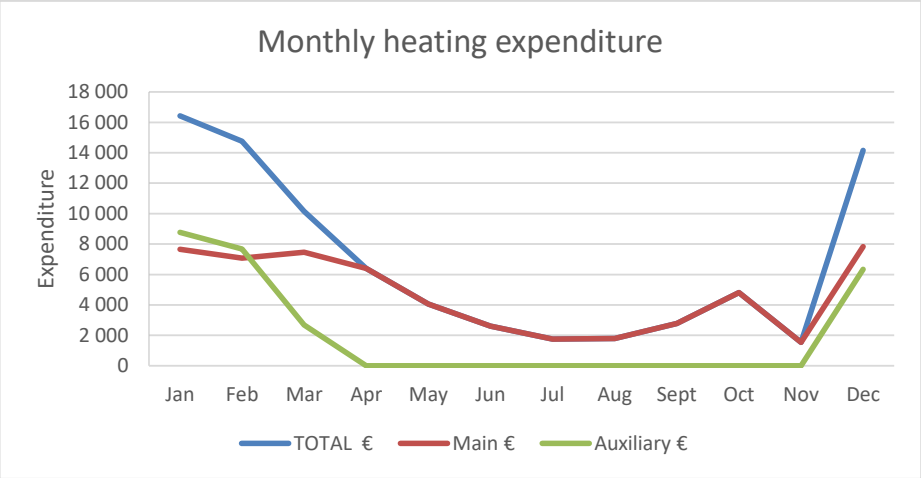
	Total	Main	Auxiliary
Energy source		CHP - recovery heat	Gas
Unit price (€/MWh)		10	35
Expenditure (€)	81 226	55 771	25 455
€ /m²	3.8	2.6	1.2
Main vs Auxiliary (cost %)		69%	31%
Consumption MWh	6 313	5 577	727
Consumpt. / unit (kWh/m²)	292	258	34
Main vs Auxiliary (energy %)		88%	12%

2. Monthly heating consumption



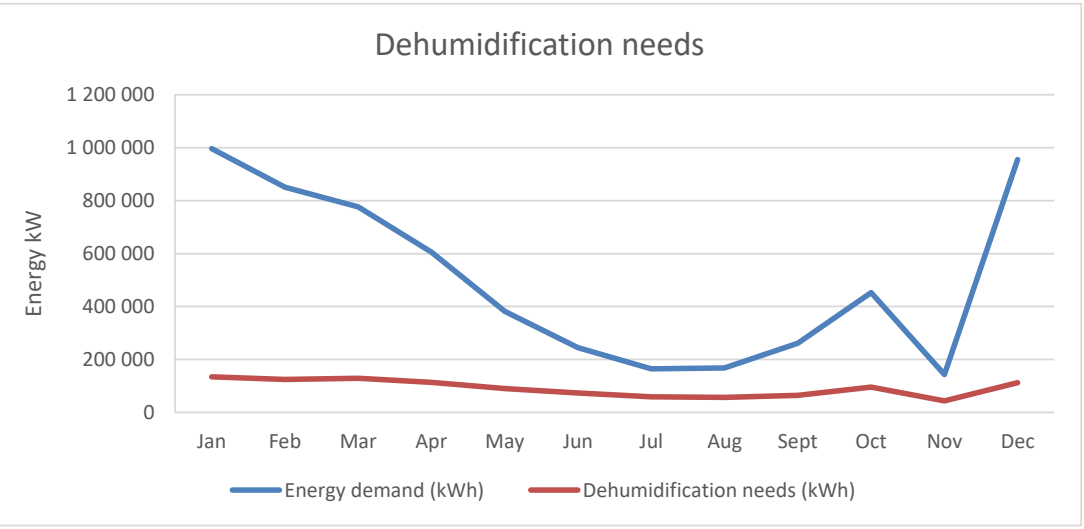
	Demand kWh	TOTAL kWh	Main kWh	Auxiliary kWh
Jan	996 444	1 016 368	765 848	250 520
Feb	850 665	926 742	707 368	219 373
Mar	776 429	823 221	746 735	76 486
Apr	604 649	639 284	639 284	0
May	381 935	405 670	405 670	0
Jun	244 771	260 626	260 626	0
Jul	164 247	175 886	175 886	0
Aug	167 673	179 493	179 493	0
Sept	261 179	277 898	277 898	0
Oct	453 181	480 111	480 111	0
Nov	143 163	153 968	153 968	0
Dec	955 240	973 578	783 158	190 420
Total	**5 999 574**	**6 312 845**	**5 576 045**	**736 800**

3. Monthly heating expenditure



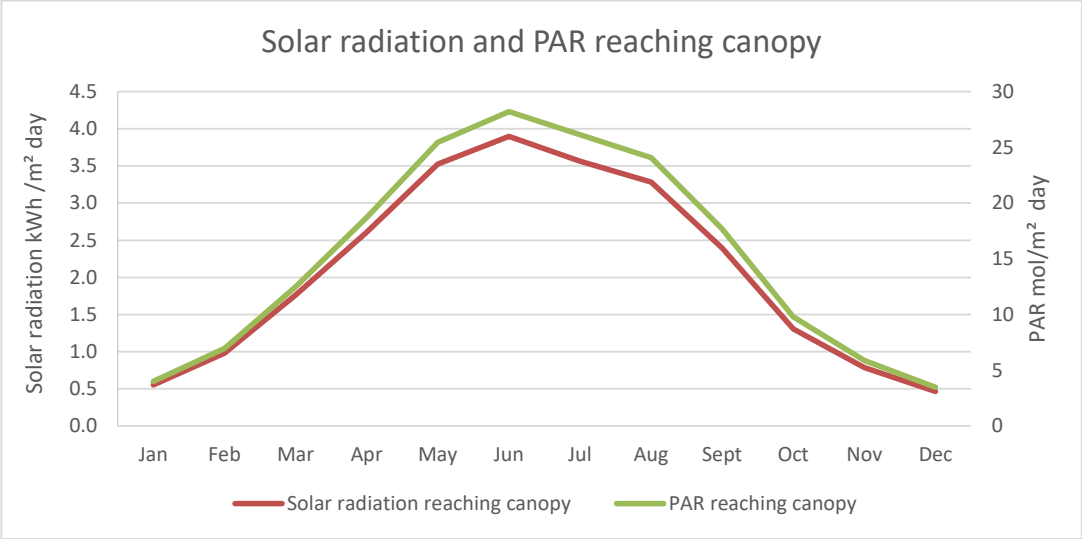
	TOTAL €	Main €	Auxiliary €
Jan	16 427	7 658	8 768
Feb	14 752	7 074	7 678
Mar	10 144	7 467	2 677
Apr	6 393	6 393	0
May	4 057	4 057	0
Jun	2 606	2 606	0
Jul	1 759	1 759	0
Aug	1 795	1 795	0
Sept	2 779	2 779	0
Oct	4 812	4 812	0
Nov	1 540	1 540	0
Dec	14 163	7 832	6 331
Total	**81 226**	**55 771**	**25 455**

4. Dehumidification needs



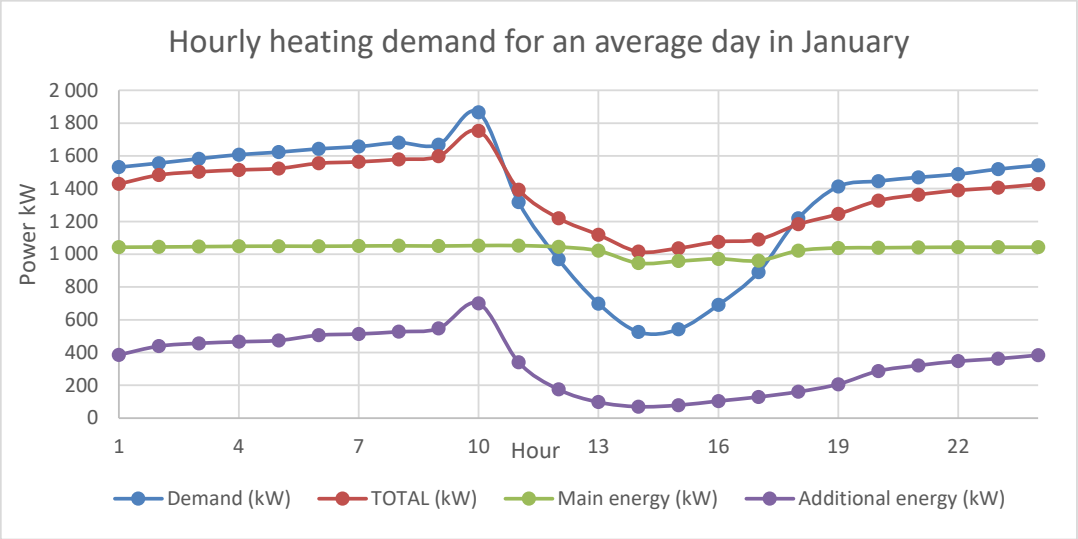
	Demand kWh	Dehumidification needs	
		kWh	%
Jan	996 444	134 498	13%
Feb	850 665	124 644	15%
Mar	776 429	129 386	17%
Apr	604 649	113 293	19%
May	381 935	90 548	24%
Jun	244 771	73 665	30%
Jul	164 247	58 549	36%
Aug	167 673	56 818	34%
Sept	261 179	64 721	25%
Oct	453 181	95 967	21%
Nov	143 163	43 674	31%
Dec	955 240	112 612	12%
Total	**5 999 574**	**1 098 376**	**18%**

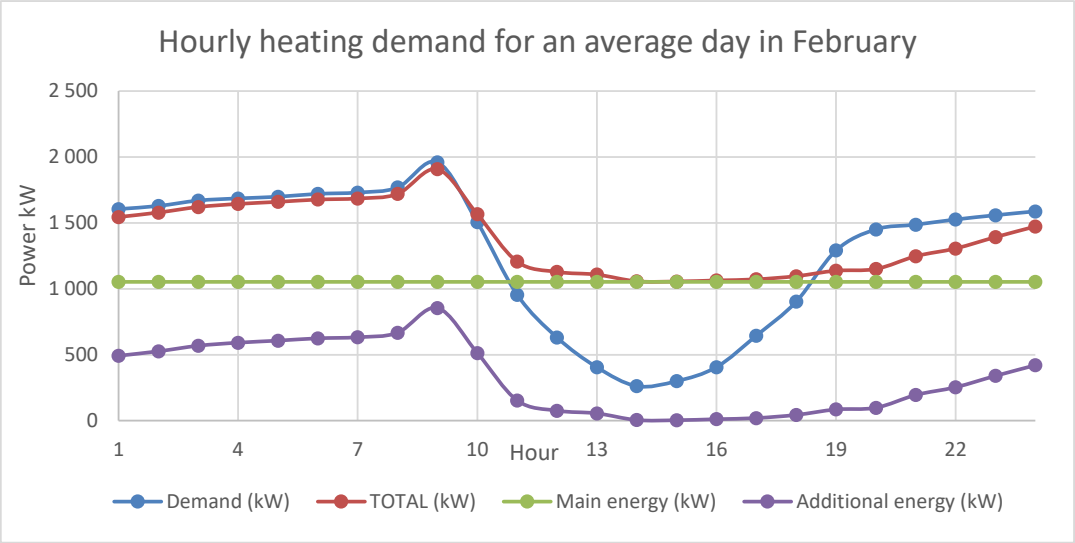
5. Solar radiation and PAR reaching canopy

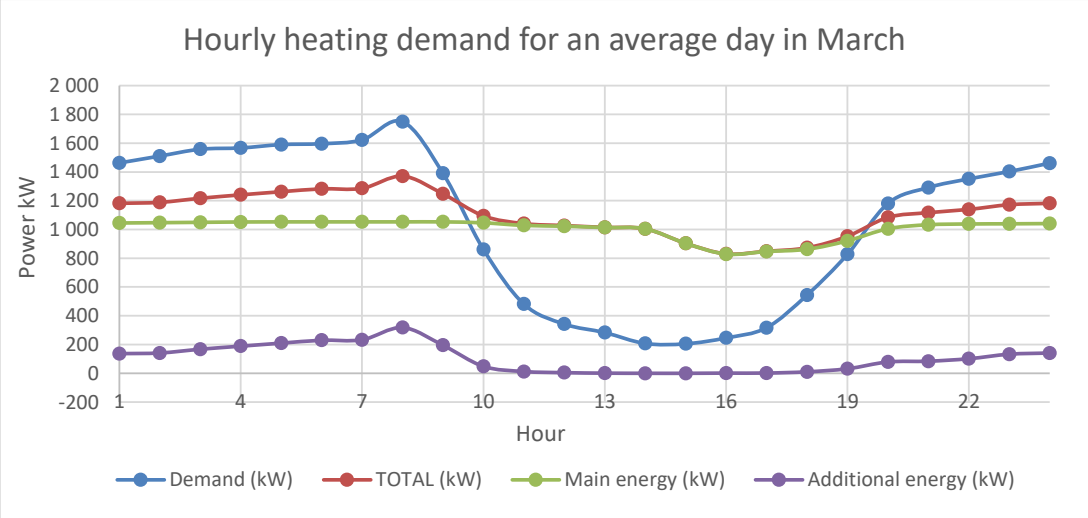


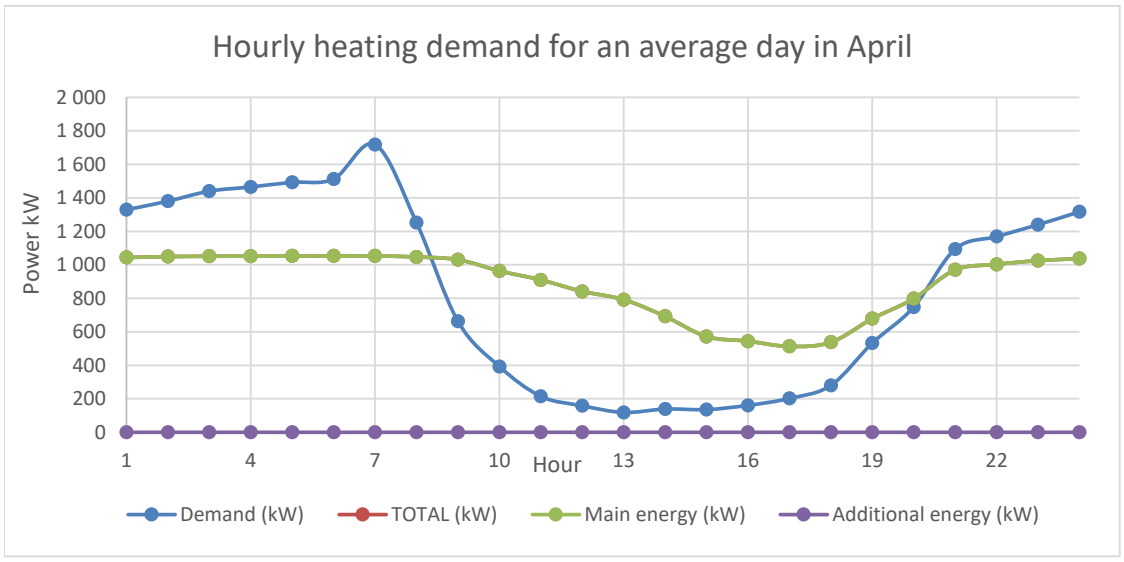
	External	Internal reaching canopy	
	Solar radiation	Solar radiation	PAR
	kWh/ m² day	kWh/ m² day	mol/m² day
Jan	0.87	0.55	4.00
Feb	1.54	0.98	6.96
Mar	2.58	1.76	12.48
Apr	3.86	2.61	18.71
May	5.05	3.53	25.45
Jun	5.45	3.90	28.21
Jul	5.07	3.57	26.13
Aug	4.56	3.28	24.08
Sept	3.47	2.40	17.69
Oct	1.98	1.31	9.78
Nov	1.15	0.79	5.88
Dec	0.75	0.46	3.47
Average	**3.03**	**2.09**	**15.24**

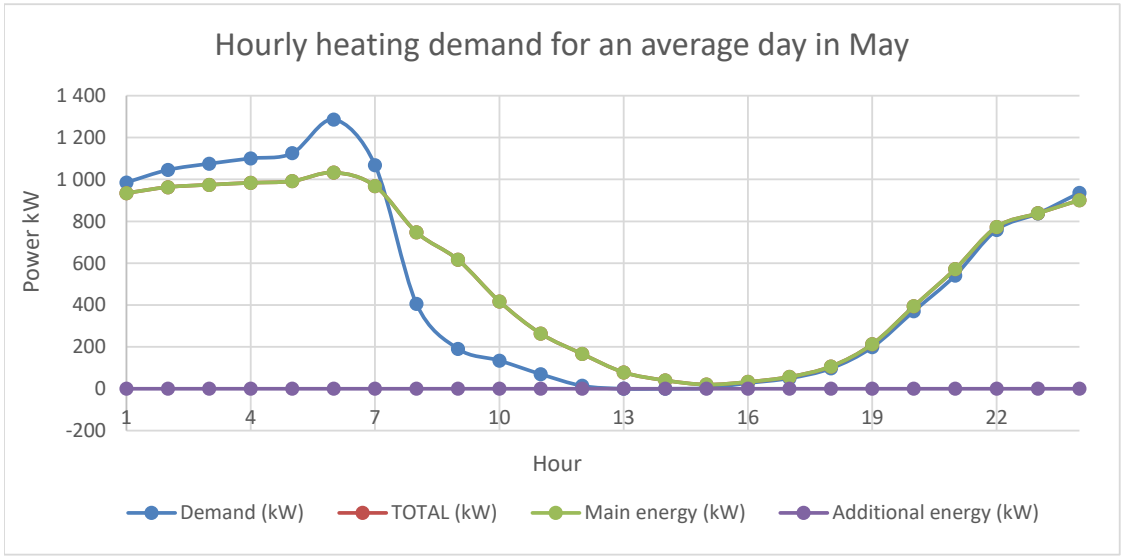
6. Daily energy consumption

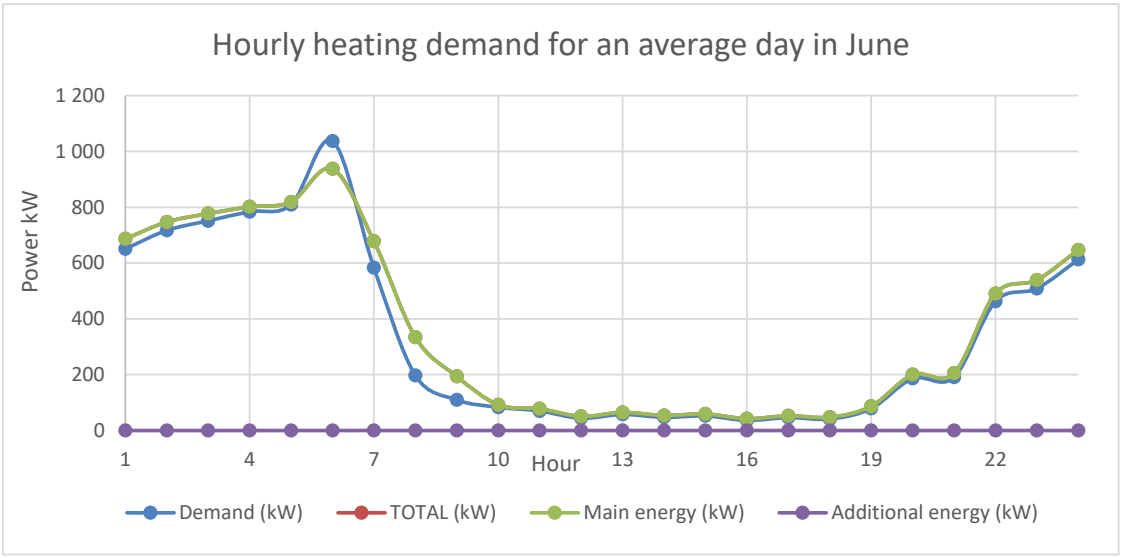


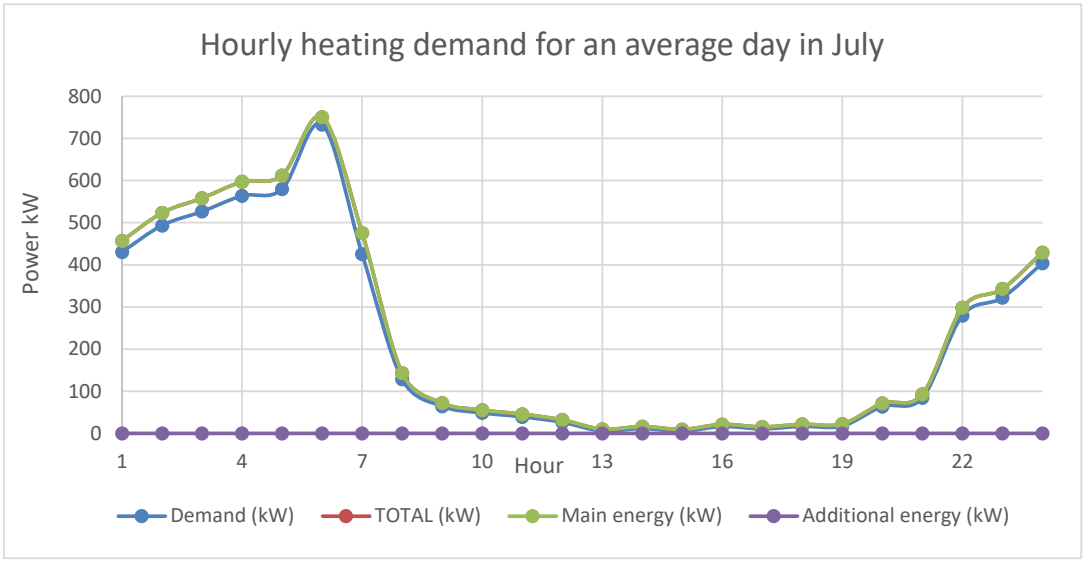


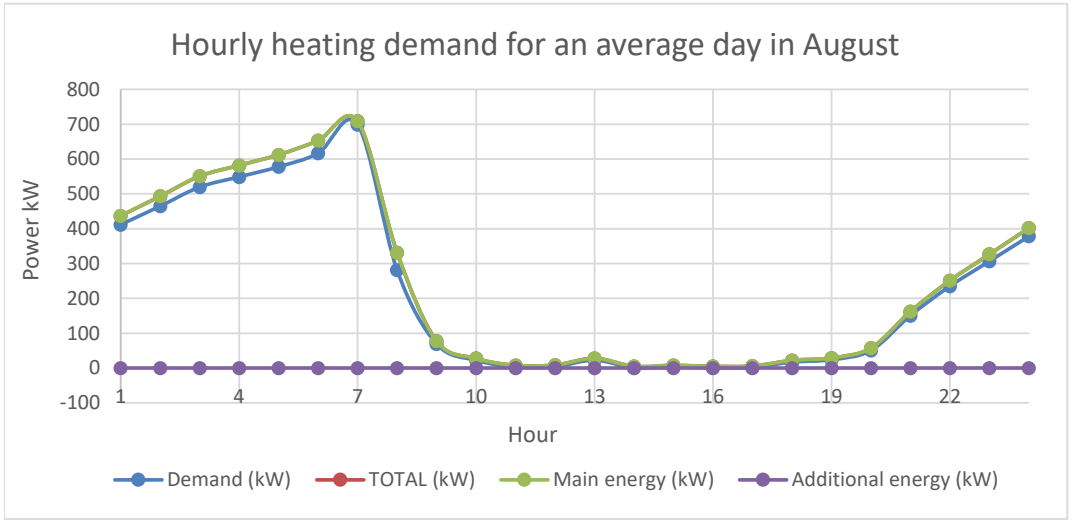


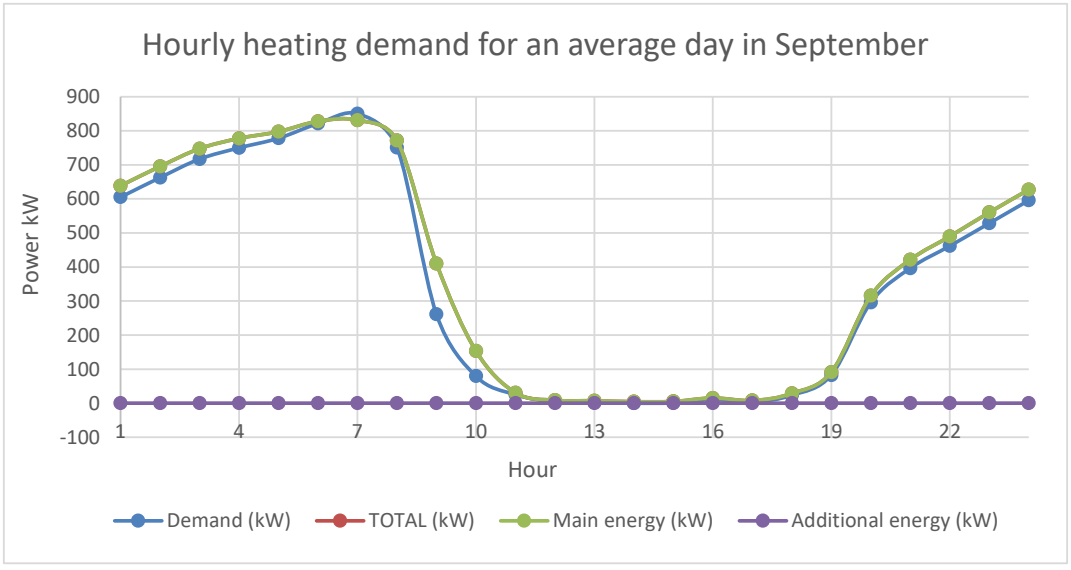

Hourly heating demand for an average day in April
Power kW
2 000
1 800
1 600
1 400
1 200
1 000
800
600
400
200
0
1
4
7
10
13
16
19
22
Hour
Demand (kW)
TOTAL (kW)
Main energy (kW)
Additional energy (kW)

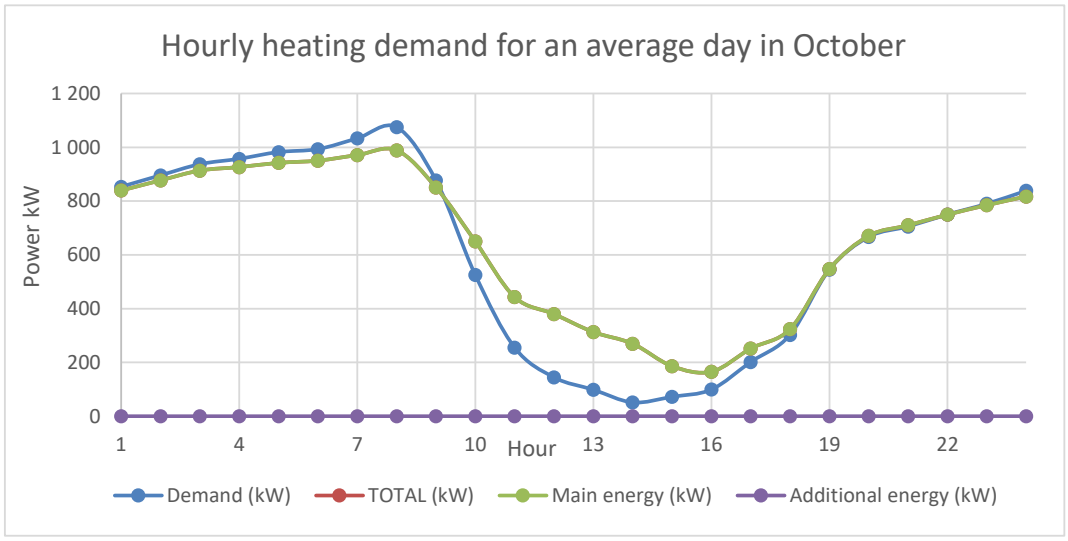

Hourly heating demand for an average day in May
Power kW
1 400
1 200
1 000
800
600
400
200
0
-200
1
4
7
10
13
16
19
22
Hour
Demand (kW)
TOTAL (kW)
Main energy (kW)
Additional energy (kW)

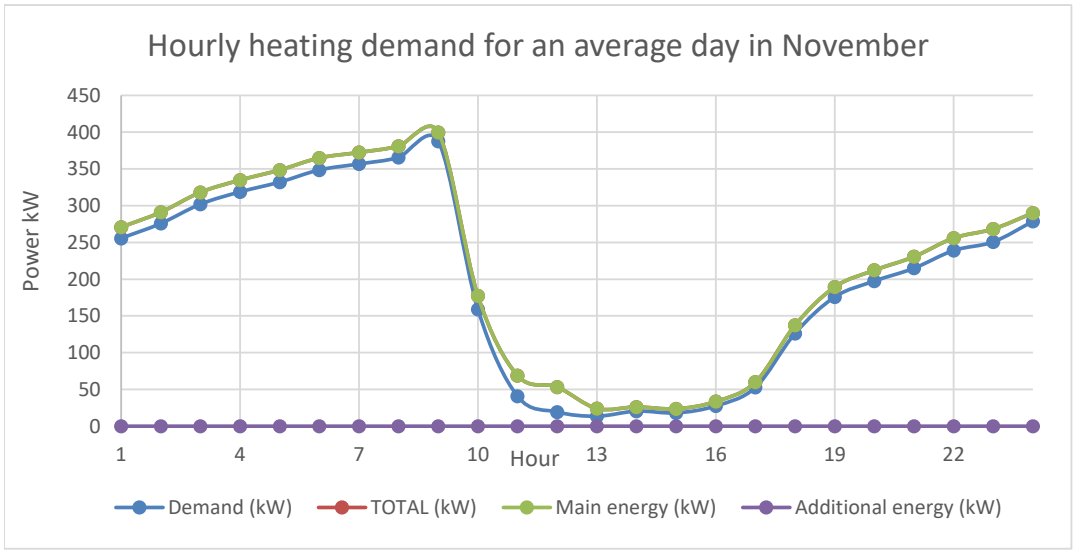

Hourly heating demand for an average day in June
Power kW
1 200
1 000
800
600
400
200
0
1
4
7
10
13
16
19
22
Hour
Demand (kW)
TOTAL (kW)
Main energy (kW)
Additional energy (kW)

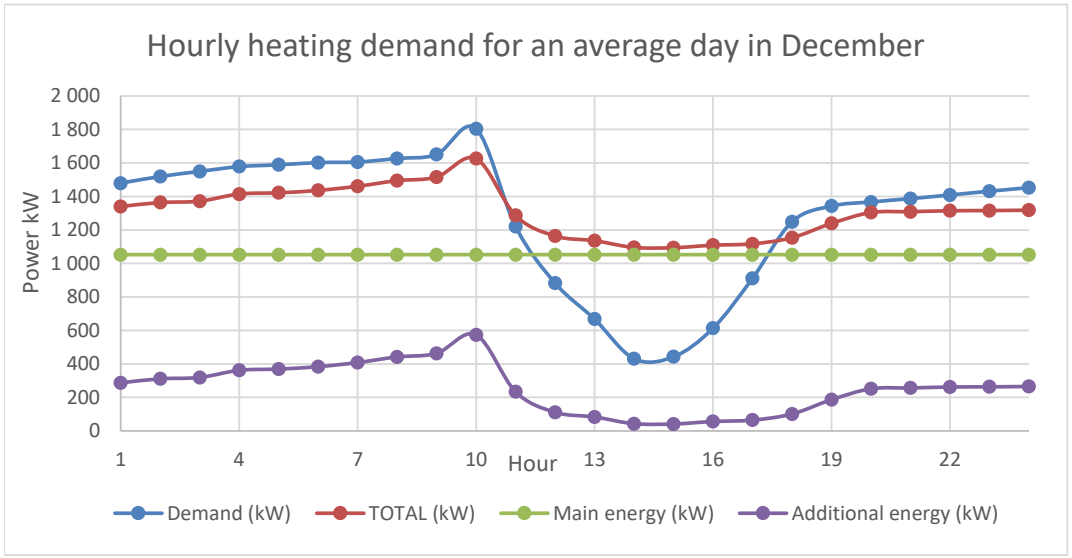

Hourly heating demand for an average day in July
Power kW
800
700
600
500
400
300
200
100
0
1
4
7
10
13
16
19
22
Hour
Demand (kW)
TOTAL (kW)
Main energy (kW)
Additional energy (kW)


Hourly heating demand for an average day in August
Power kW
800
700
600
500
400
300
200
100
0
-100
1
4
7
10
13
16
19
22
Hour
Demand (kW)
TOTAL (kW)
Main energy (kW)
Additional energy (kW)

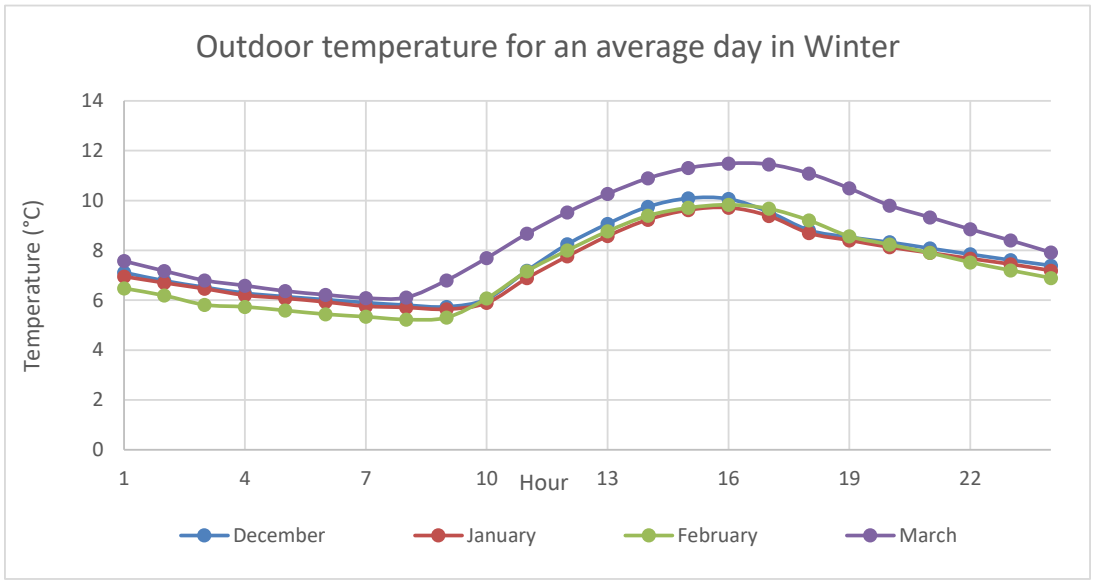

Hourly heating demand for an average day in September
Power kW
900
800
700
600
500
400
300
200
100
0
-100
1
4
7
10
13
16
19
22
Hour
Demand (kW)
TOTAL (kW)
Main energy (kW)
Additional energy (kW)

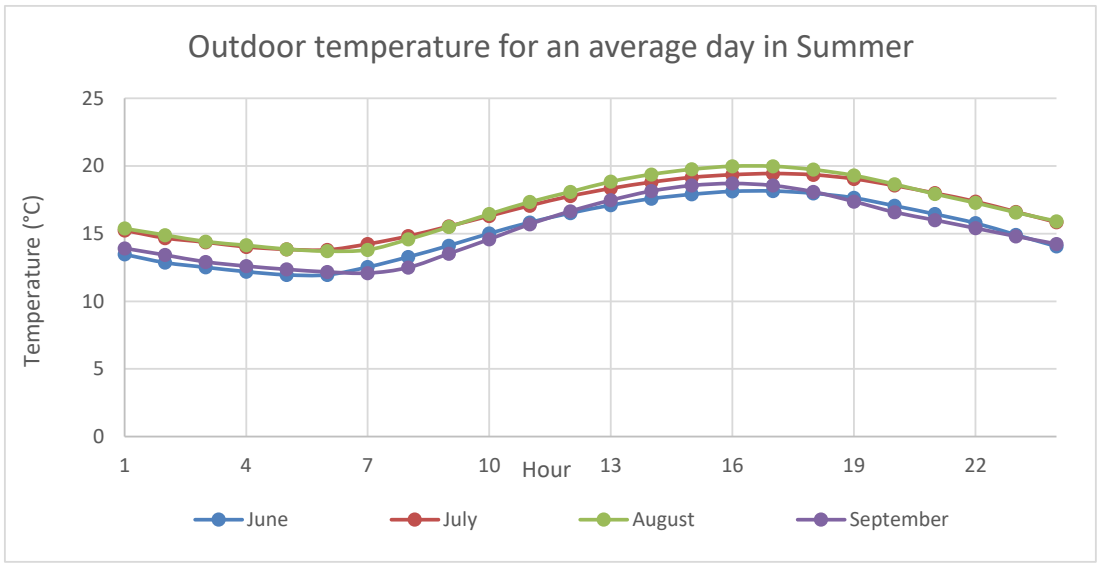

Hourly heating demand for an average day in October
Power kW
1 200
1 000
800
600
400
200
0
1
4
7
10
13
16
19
22
Hour
Demand (kW)
TOTAL (kW)
Main energy (kW)
Additional energy (kW)

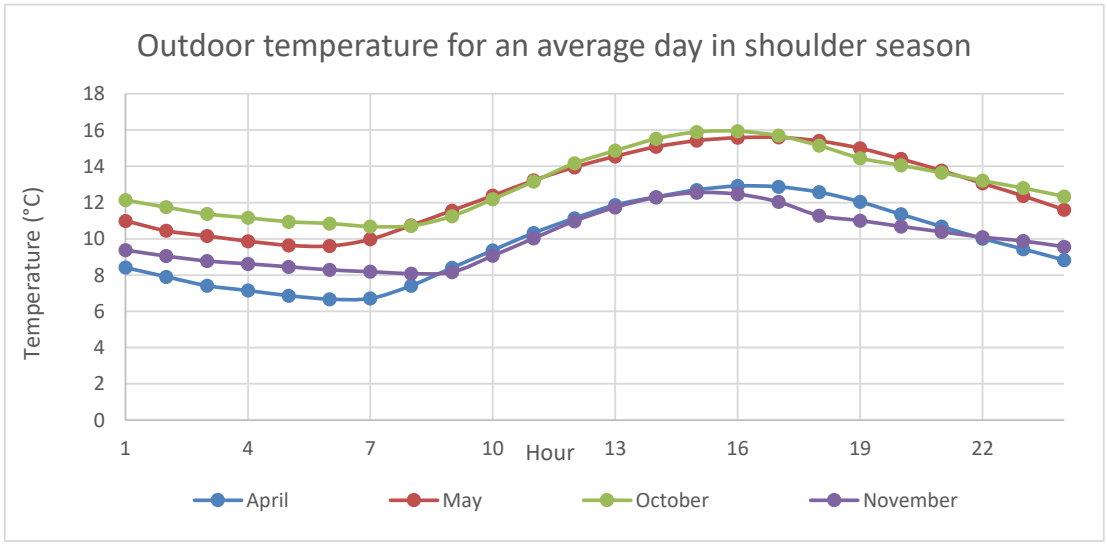

Hourly heating demand for an average day in November
Power kW
450
400
350
300
250
200
150
100
50
0
1
4
7
10
13
16
19
22
Hour
Demand (kW)
TOTAL (kW)
Main energy (kW)
Additional energy (kW)

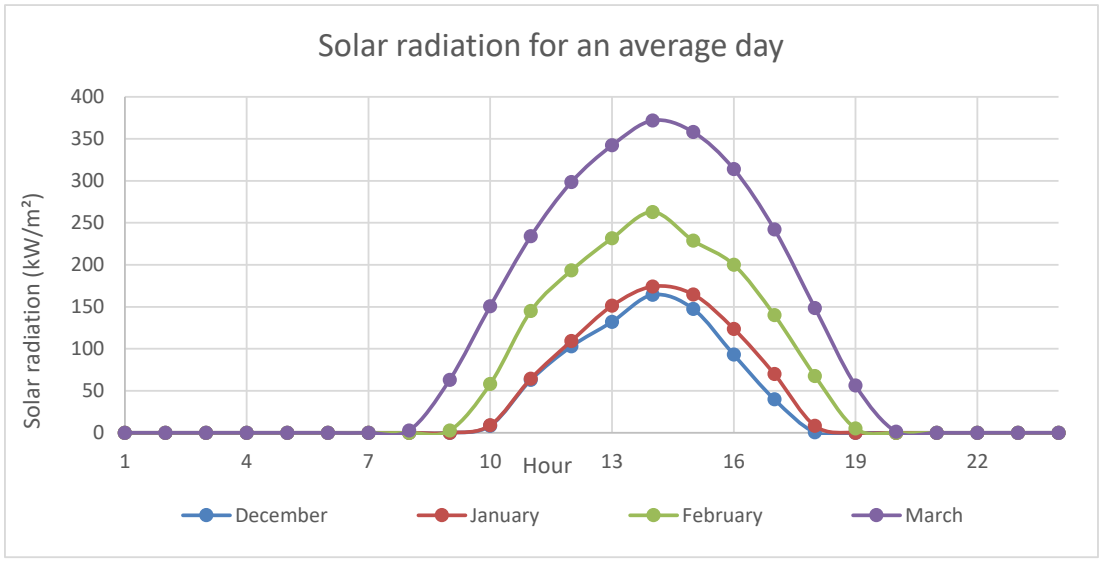

Hourly heating demand for an average day in December
Power kW
2 000
1 800
1 600
1 400
1 200
1 000
800
600
400
200
0
1
4
7
10
13
16
19
22
Hour
Demand (kW)
TOTAL (kW)
Main energy (kW)
Additional energy (kW)

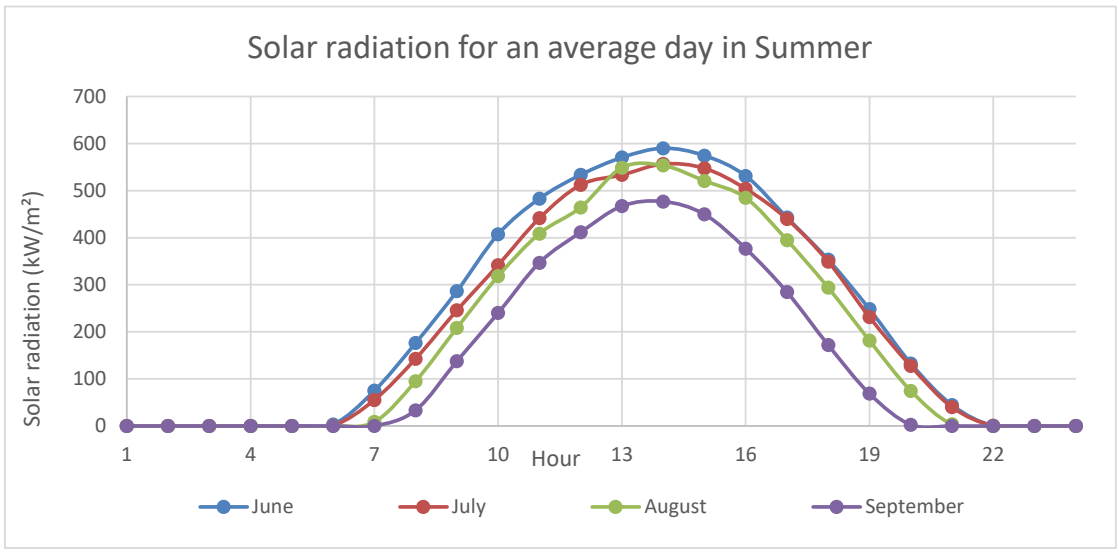
7. Outdoor climate

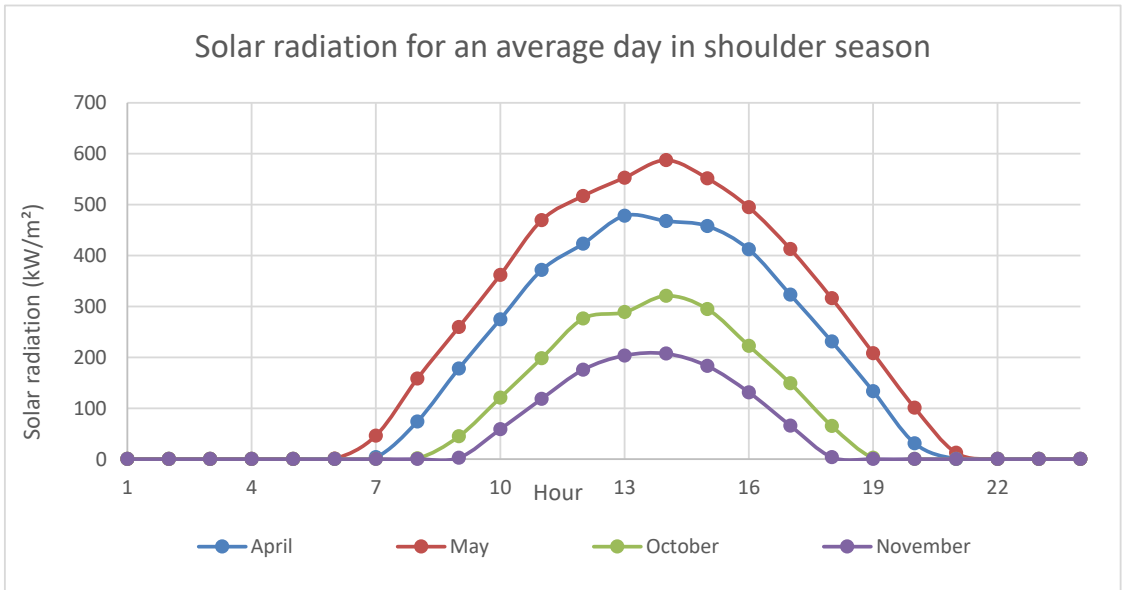







Solar radiation for an average day
Solar radiation (kW/m²)
400
350
300
250
200
150
100
50
0
1
4
7
10
13
16
19
22
Hour
December
January
February
March


Solar radiation for an average day in Summer
Solar radiation (kW/m²)
700
600
500
400
300
200
100
0
1
4
7
10
13
16
19
22
Hour
June
July
August
September


Solar radiation for an average day in shoulder season
Solar radiation (kW/m²)
700
600
500
400
300
200
100
0
1
4
7
10
13
16
19
22
Hour
April
May
October
November