PUNTO DE REUNIÓN

Energy Calculations + Ventilation (Be10)

JAN REYNDERS

MARC ANDRÉ KUHNERT

MICAEL PEPE

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1. General

1.1 Dividing of building

„Punto de Reunion" is a multi storey building of 3 storey's high and a ventilated basement. The building is devided in different functions for each floor.

- Basement for parking and untilities (ventilation system, heating, water,...),
- Groundfloor for commercial acitivities:
  - Bar/lounge
  - Spa/welness
  - Office space for spa
  - First aid/ doctors practice
  - Polyvalent space
- First floor for student accomodation
- 2nd floor for penthouse

Due to this mixed use of the building we seperated the building according to functionality. The Groundfloor (1321 m²) was taken as commercial area, the 1st and 2nd floor (1182 m²) are seen as accomodation or dwellings. The basement is left out of the calculation since this space is naturally ventilated and does not require additional heating or cooling.

If the commercial area occupied less then 20% of the total floor area of the building, this could be included in the calculation for the accomodation. But since the commercial area consist of

$$1321 \,/\, (1321+1182) = 0.52 \rightarrow 52\%$$

of the total floor area we had to seperate the building into different area to do the calculations accurately (see chapter 2 and 6).

1.2 General energy concept of the building

Our client's roots are located in Mexico, so in this building we wanted to recreate an indoor climate that could resemble that of Mexico.
The way we did this is by spliting the building into 2 pieces and opening up the space in between towards the south. This way we achieved a maximum amount of solar gain. To optimise the use of this solar load and enable to growth of more exotic plants on the property we decided to connect the two building masses by a winter garden, acting as a giant greenhouse.

Further more we wanted to store as much as possible of this solar load, so we worked, especially on the groundfloor, with heavy materials like concrete and rammed earth wall. These materials have a high thermal mass, so they are exellent in storing heat.
The higher the building, the lighter the material, thus optimising the heat stack upwards.

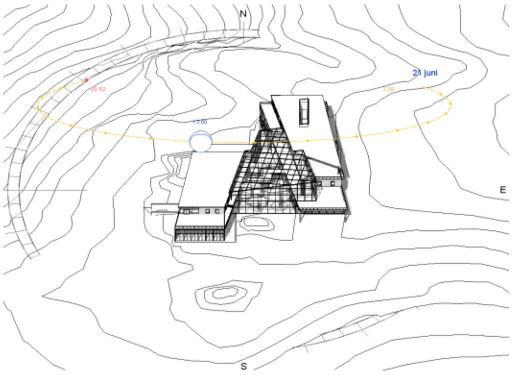

Figure 1: Solar path on building (21 June)

2. Month average calculation

During the outline proposal we finished the design of the house. Once this was done we made our first estimation of the energy consumption of the „Punto de reunion“ multi storey building; The Month average calculation.

As we said before, we had to split the building in 2 area's to obtain the most accurate representation of our building's energy phrame. The commercial area on the groundflloor and the acommodation on the 1st and 2nd floor, doing a *month average calculation* for each area seperately.

2.1 Month average calculation of commercial area

When doing *the Month average calculation* for the commercial area it became clear that our main focus should be on the heating of the building. In this area we lost 83.1 kWh/m²/year. Especially when compared to our energy los for cooling which is only 0.1 kWh/m²/year. This big difference can be explained by the geographical position of our building in the Northern part of Denmark.

Month Average Calculation

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Building data

Roomtemperatur in case of heating, °C	20
Roomtemperatur in case of cooling °C	24
Ground temperature, °C	7,6
Net ground area, m²	1253,46
Heated floor area, m²	1361,4
Heated built area, m² (foot print)	1361,4
Service life, hours/week	74
Relative service life	0,440

Weather data

Choose destination
Copenhagen

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Heating and cooling demands of the building

Month	Number of days	Cooling demand kWh/month	Heat demand kWh/month	Ventilation loss W/K	Utility factor	Solar gain kWh	Internal gain kWh	Gains caused by tu>ti kWh	Heat loss with winter temp. kWh	Heat loss with summer temp. kWh
Jan	31	0	22573	1050	1,000	2033	3828	0	28433	34079
Feb	28	0	18379	1050	1,000	3273	3457	0	25108	30207
Mar	31	0	15707	1050	0,998	5227	3828	0	24746	30392
Apr	30	0	7983	1050	0,980	7560	3704	0	19025	24489
May	31	0	1816	1050	0,844	9785	3828	0	13302	18947
June	30	142	130	1050	0,565	9483	3704	0	7581	13045
July	31	0	799	2437	0,755	9310	3828	0	10715	20489
Aug	31	0	109	1050	0,556	8474	3828	0	6944	12590
Sep	30	0	1763	1050	0,875	6179	3704	0	10412	15875
Oct	31	0	8097	1050	0,992	3985	3828	0	15845	21491
Nov	30	0	14830	1050	1,000	2216	3704	0	20748	26212
Dec	31	0	20965	1050	1,000	1352	3828	0	26145	31790
SUM		***142***	***113152***			***68878***	***45070***	***0***	***209003***	***279604***

Result

Energy consumption for heating pr m² floor area, kWh/m² år	**83,1**
Energy consumption for cooling pr m² floor area, kWh/m² år	**0,1**
Total energy consumption pr m² floor area, kWh/m² år	**83,2**

For comparison

Energy frame, dwellings	71,6 kWh/m² år
Low energy class 2	51,2 kWh/m² år
Low Energy class 1	35,8 kWh/m² år

Tabel 1: Month average calculation commercial area (Heating and cooling)

All together we would have a energy consumption of 83.2 kWh/m²/year which is far above the average energy consumption found in low energy buildings (class 2: 51.2 and class 1: 35.8).

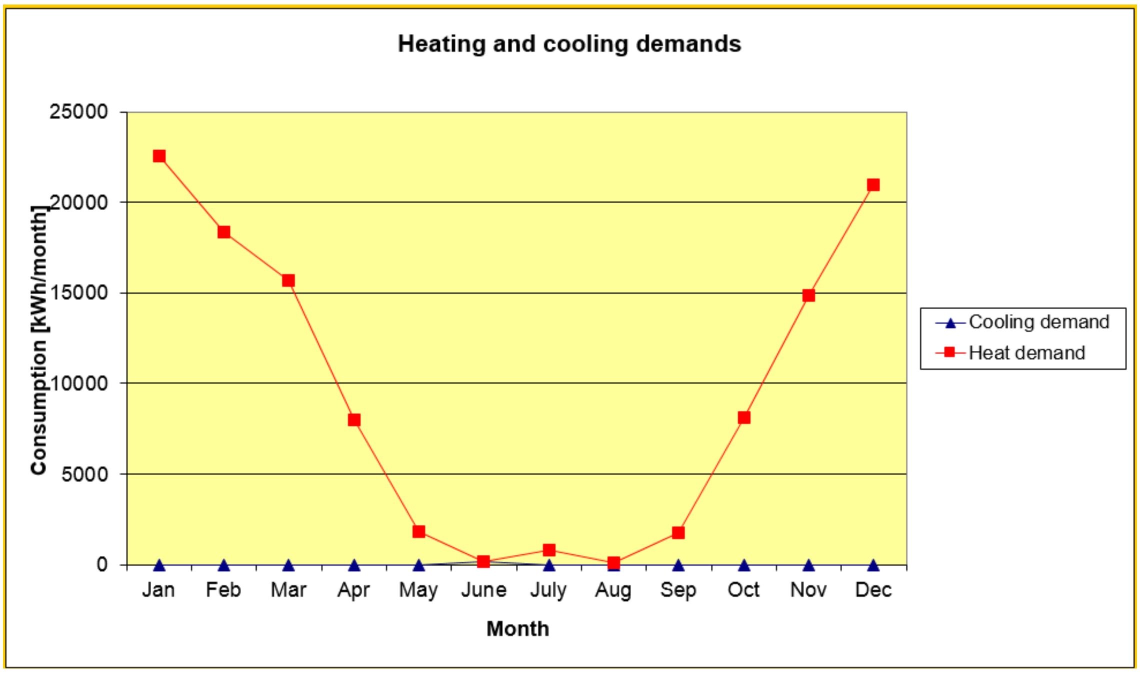
Some of the measurements we took to reduce the heat consumption in the commercial area are:

Passive measurements :

- Wintergarden
- Combination of big windows and Thermal mass to store the solar heat (1:6 ratio)
- Heat corridor's for natural ventilation (also for overheating in summer)

Active measurements:

- Controlable shading (also for overheating in summer)
- *Heat pum



Graph 1: Month average calculation commercial area: Energy consumption throughout the year

Tabel 2: Characteristics of the building; commercial area

Characteristics of the building

Constructions towards outdoor

A m²	Description	U W/m²K	Bu W/K	
133,95	nordvæg	0,15	20,0925	
138,231	østvæg	0,15	20,73465	
119,9	vestvæg	0,15	17,985	
0	sydvæg	0,15	0	
1361,4	tag	0,1	136,14	
			0	
			0	
			0	
			0	
Specific heat loss, constructions towards outdoor, (W/K)			194,95215	= Bu,con

Windows

A m²	Direction	U W/m²K	Bu W/K	g-value [-]	f(beta) [-]	f(shade) [-]	f(shadow) [-]	f(glass) [-]	Fsun [-]
43,97	N	0,79	34,7363	0,51	0,9	0,65	0,5	0,9	0,1342575
124,066	NE	0,79	98,01214	0,51	0,9	0,65	0,8	0,9	0,214812
78,15	E	0,79	61,7385	0,51	0,9	0,65	0,5	0,9	0,1342575
	SE		0						0
178,323	S	0,79	140,87517	0,51	0,9	0,65	0,9	0,9	0,2416635
	SW		0						0
	W		0						0
163,31	NW	0,79	129,0149	0,51	0,9	0,65	0,5	0,9	0,1342575
	Skylight		0						0
Specific heat loss, windows, (W/K)			464,37701	= Bu,win					

Specific heat loss, outdoors, total: (W/K)		659,32916	= Bt (=Bu,con+Bu,win)

Floor

A m²	U W/m²K	Bu W/K	
1253	0,15	187,95	
		0	
		0	
		0	
		0	
Specific heat loss, floor, (W/K)		187,95	= Bu,floor

Heat capacity

Heat capacity, Wh/Km²	160
Time constant	77,4
a	5,8

Tabel 3: Ventilation commercial area

Ventilation

Ventilation rate, summer

Service hours, l/s m2	2,78
Outside service hours, l/s m2	0,69
Average ventilation rate, m3/s	2,02

Ventilation loss, summer, W/K	**2437**	=Bv,summer

Ventilation rate, winter

Service hours, l/s m2	0,69
Outside service hours, l/s m2	0,69
Average ventilation rate, m3/s	0,87

Ventilation loss, winter W/K	**1050**	=Bv,winter

Internal heat loads

Hour	Person load W	Ligthing W	Other W	Total W	
1	0	0	500	500	
2	0	0	500	500	
3	0	0	500	500	
4	0	0	500	500	
5	0	0	500	500	
6	0	0	500	500	
7	265	4084	800	5149	
8	663	4084	800	5547	
9	663	4084	800	5547	
10	663	4084	800	5547	
11	663	4084	800	5547	
12	1658	4084	800	6542	
13	2231	4084	800	7115	
14	2231	4084	800	7115	
15	1658	4084	800	6542	
16	1658	4084	800	6542	
17	1989	4084	800	6873	
18	1989	4084	800	6873	
19	2652	4084	800	7536	
20	3978	4084	800	8862	
21	3978	4084	800	8862	
22	3978	4084	800	8862	
23	1685	4084	800	6569	
24	265	4084	500	4849	
Total	32867	73512	17100	123479	
Average	1369	3063	713	5145	$=\Phi i$

Pr. m² floor area	Person load W/m²	Ligthing W/m²	Other W/m²	Total W/m²
Average	1,09	2,44	0,57	4,10

Help for internal loads

Heat from persons:	Activity level met	Total W/person	Sensible heat W/person	Number of persons	Sensible, total W
	1,0	99	66	60	3978

Ligthing: General	Level: lux	Incandescent lig W/m² g.a.	fluorescent W/m² g.a.	Lowenergy W/m² g.a.	Choose power W/m² g.a.	Ligthing total, W
	180	47	14	7	3	4084

Tabel 4: Internal heat loads commercial area

2.1 Month average calculation of accommodation

Month Average Calculation

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Building data

Roomtemperatur in case of heating, °C	19
Roomtemperatur in case of cooling °C	24
Ground temperature, °C	7,6
Net ground area, m²	1158,536
Heated floor area, m²	1271,976
Heated built area, m² (foot print)	1065,849
Service life, hours/week	40
Relative service life	0,238

Weather data

Choose destination
Copenhagen

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Heating and cooling demands of the building

Month	Number of days	Cooling demand	Heat demand	Ventilation loss	Utility factor	Solar gain	Internal gain	Gains caused by tu>ti	Heat loss with winter temp.	Heat loss with summer temp.
		kWh/month	kWh/month	W/K		kWh	kWh	kWh	kWh	kWh
Jan	31	0	12305	582	1,000	926	2195	0	15425	19560
Feb	28	0	10119	582	1,000	1516	1983	0	13617	17352
Mar	31	0	8758	582	0,999	2452	2195	0	13402	17537
Apr	30	0	4600	582	0,990	3603	2124	0	10269	14270
May	31	0	1054	582	0,880	4700	2195	0	7122	11257
June	30	0	58	582	0,588	4563	2124	0	3989	7991
July	31	0	25	582	0,520	4477	2195	0	3494	7629
Aug	31	0	45	582	0,572	4082	2195	0	3634	7769
Sep	30	0	991	582	0,904	2907	2124	0	5542	9544
Oct	31	0	4481	582	0,996	1859	2195	0	8518	12653
Nov	30	0	8069	582	1,000	1022	2124	0	11214	15216
Dec	31	0	11354	582	1,000	621	2195	0	14169	18305
SUM		***0***	***61859***			***32727***	***25843***	***0***	***110396***	***159083***

Result

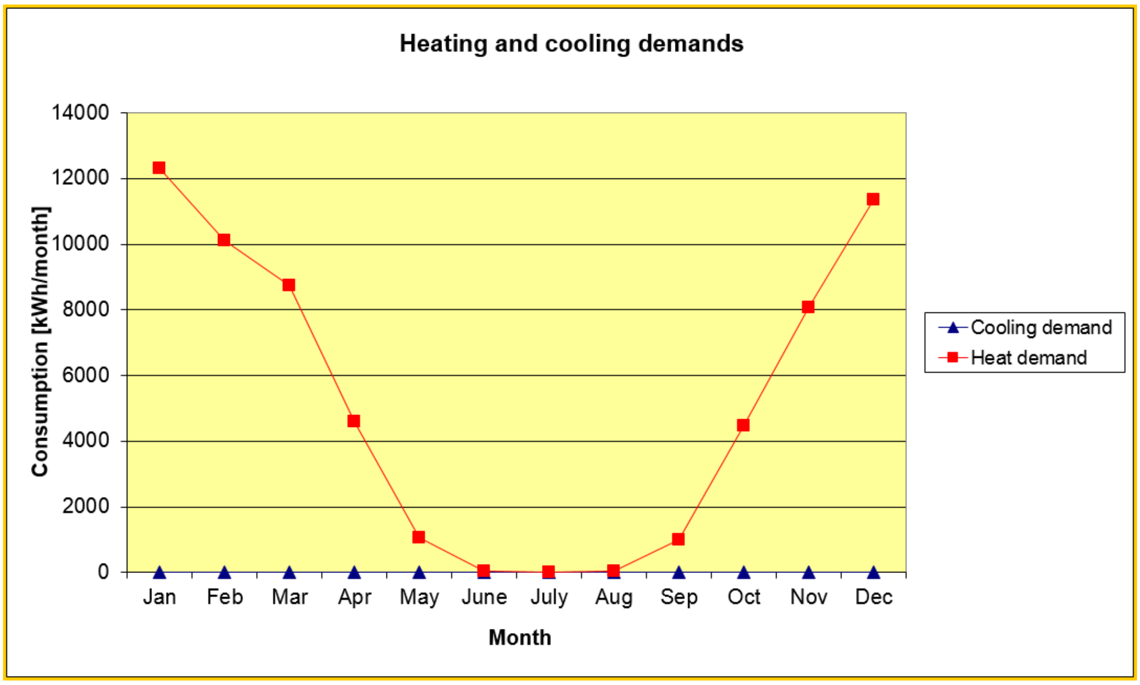
Energy consumption for heating pr m² floor area, kWh/m² år	**48,6**
Energy consumption for cooling pr m² floor area, kWh/m² år	**0,0**
Total energy consumption pr m² floor area, kWh/m² år	**48,6**

For comparison

Energy frame, dwellings	71,7 kWh/m² år
Low energy class 2	51,3 kWh/m² år
Low Energy class 1	35,9 kWh/m² år

Tabel 5: Month average calculation accommodation (heating and cooling)

In the *Month average calculation* for the accommodation area of the building find the same trend as in the commercial area. A high energy consumption for heating of 48.6 kWh/m²/year in comparisant to 0.0 kWh/m²/year for cooling. But unlike the commercial area it is not in this amount that it causes a problem in overal energy consumption of the building, since the accommodation still performs better then a energy class 2 house (48.6 kWh/m²/year vs 51.3 kWh/m²/year).



Graph 2: Month average calculation: Energy consumption throughout the year

This difference can be brought back to a lower service life, less glasing and a use of lighter construction materials. In this calculation the use of less glass and lighter construction materials will be benificial for the outcome of the calculation, although this in practive might not be the case.

As we mentionned before, the combination of bigger windows and thermal mass (concrete floor/walls, rammed earth walls, soill in wintergarden) will contribute to a better preservation of the solar load instead of a loss to the outside. Another point is the orientation of the windows and thermal mass towards the wintergarden, wich will lead to an even greater usage of solar power for the heat gain.

Characteristics of the building

Constructions towards outdoor

A m^2	Description	U W/m^2K	Bu W/K	
154,702	nordvæg	0,15	23,2053	
140,84	østvæg	0,15	21,126	
135,802	vestvæg	0,15	20,3703	
59,867	sydvæg	0,15	8,98005	
1068,251	tag	0,1	106,8251	
			0	
			0	
			0	
			0	
Specific heat loss, constructions towards outdoor, (W/K)			180,50675	= Bu,con

Windows

A m^2	Direction	U W/m^2K	Bu W/K	g-value [-]	f(beta) [-]	f(shade) [-]	f(shadow) [-]	f(glass) [-]	Fsun [-]
31,89	N	0,79	25,1931	0,51	0,9	0,65	0,5	0,9	0,1342575
53,112	NE	0,79	41,95848	0,51	0,9	0,65	0,8	0,9	0,214812
0	E	0	0	0	0	0	0	0	0
7,024	SE	0,79	5,54896	0,51	0,9	0,65	0,8	0,9	0,214812
60,955	S	0,79	48,15445	0,51	0,9	0,65	0,9	0,9	0,2416635
34,615	SW	0,79	27,34585	0,51	0,9	0,65	0,8	0,9	0,214812
0	W	0	0	0	0	0	0	0	0
4,848	NW	0,79	3,82992	0,51	0,9	0,65	0,5	0,9	0,1342575
29,25	Skylight	0,79	23,1075	0,51	0,9	0,65	0,8	0,9	0,214812
Specific heat loss, windows, (W/K)			175,13826	= Bu,win					

Specific heat loss, outdoors, total: (W/K)	355,64501	= Bt (=Bu,con+Bu,win)

Floor

A m^2	U W/m^2K	Bu W/K	
1150,536	0,15	173,7804	
		0	
		0	
		0	
		0	
Specific heat loss, floor, (W/K)		173,7804	= Bu,floor

Heat capacity

Heat capacity, Wh/Km²	100
Time constant	87,8
a	6,5

Tabel 6: Characteristics of the building: accomodation

Ventilation

Ventilation rate, summer	
Service hours, l/s m2	1,67
Outside service hours, l/s m2	0,42
Average ventilation rate, m3/s	0,83
Ventilation loss, summer, W/K	998 =Bv,summer

Ventilation rate, winter	
Service hours, l/s m2	0,42
Outside service hours, l/s m2	0,42
Average ventilation rate, m3/s	0,48
Ventilation loss, winter W/K	582 =Bv,winter

Tabel 7: Ventilation accommodation

Internal heat loads

Hour	Person load W	Ligthing W	Other W	Total W
1	1016	0	0	1016
2	1016	0	0	1016
3	1016	0	0	1016
4	1016	0	0	1016
5	1016	0	0	1016
6	1016	0	0	1016
7	1016	0	0	1016
8	1548	3816	2000	7364
9	1548	3816	2000	7364
10	1548	3816	2000	7364
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	1548	0	1200	2748
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	1548	3816	2000	7364
19	1548	3816	2000	7364
20	1548	3816	2000	7364
21	1548	3816	2000	7364
22	1548	3816	2000	7364
23	1016	0	0	1016
24	1016	0	0	1016
Total	23076	30528	17200	70804
Average	962	1272	717	2950 =Φi

Pr. m^2 floor area	Person load W/m^2	Ligthing W/m^2	Other W/m^2	Total W/m^2
Average	0,83	1,10	0,62	2,55

Help for internal loads

Heat from persons:	Activity level met	Total W/person	Sensible heat W/person	Number of persons	Sensible, total W
	1,4	138	86	18	1548

Ligthing: General	Level: lux	Incandescent lig W/m^2 g.a.	fluorescent W/m^2 g.a.	Lowenergy W/m^2 g.a.	Choose power W/m^2 g.a.	Ligthing total, W
	120	31	10	5	3	3816

Tabel 8: Internal heat loads accommodation

3. Drainage, water and utility shafts

3.1 Shaft diagram

The *shaft diagram* gives a good overview of the different utilities that enter the building and more specific the different appartments.

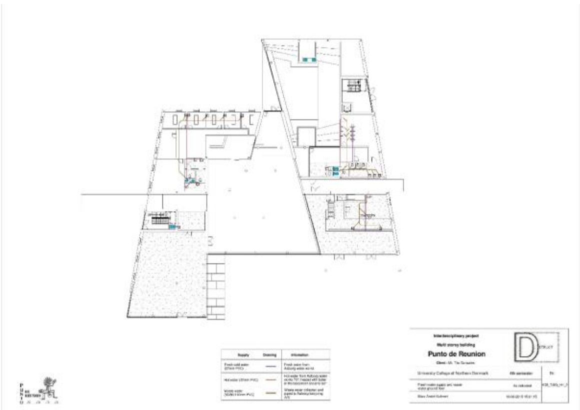
It also shows the way the different pipes for the different utiluties must be organised.

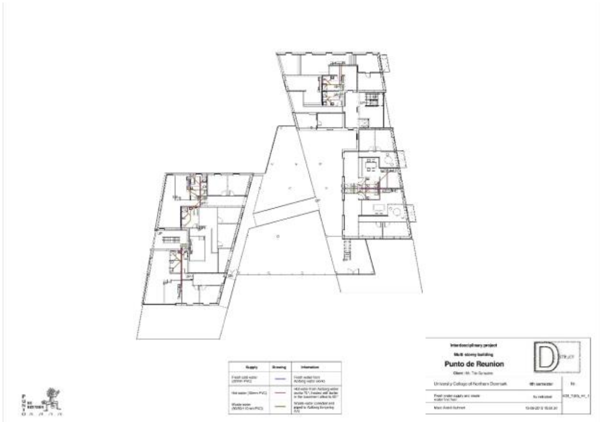
The pipes that supply hot water must be insulated to prevent heat loss by transmission. The drainage pipe must be insulated as well, but his time to prevent unneccessary sound polution.

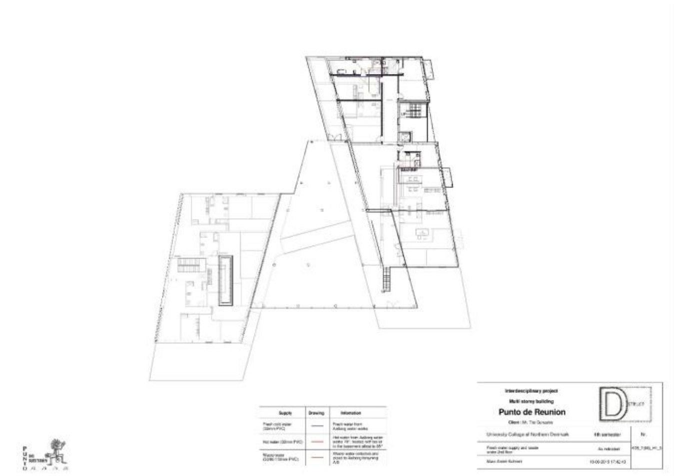
3.2 Appartment plan (utility plan)

The appartment plan shows the way the different utilities like drainage, supply of hot and cold water, circulated hot water, heating pipes (flow and return) and electricity are distributed throughout the floor plan.

It helps to place the different area's that need to be supplied (like kitchen, bathroom, toilet, ...) close together. This way you save on meters of cable, you will have less transmission heat loss and you keep the utility plan organised.







4. Mechanical ventilation

4.1 General

Although we tend to use as much as possible natural ventilation to keep the operation cost low, this is not possible during the entire year. In the winter we must keep the heat indoors and at those moments *Mechanical ventilation* will be needed to garantee a good indoor climate by supplying fresh air and extract pollutants that might build up in the building (odurs, CO^2,...)

4.2 Ventilation calculation (+duct sizing)

In the ventilation calculation we calculate the *air amount* that needs to be displaced to maintain a healthy indoor air climate. This includes the amount of fresh air that needs to be supplied as the amount of dirty air that will be extracted.
The surface of the room that needs to be ventilated and the height of the room will have a impact on the air amount. But also the function of the room has an impact. A bathroom will need it's air more refreshed then a corridor for example.

Guiding air amounts

Type of building/space	Ventilation rate [l/s/m²] floor area	Ventilation rate [l/s]
Staff rooms		
Changing room	8 – 12	
Dining room	8 - 10	
Resting room		15/person
Restaurant	10	
Cafeteria	4	
Schools		
Classroom	4 - 5	
Sport halls	3 – 4	
Bowling halls	3 – 4	
Billiard room	8 - 10	
Hospital		
Treatment and receiving rooms for infect patients	9	
Dialysis room	42	
Intensive room	28	
Injection room	28	
Post-mortem room	9	
Operating room	14	
Recovery room	28	
Timber industry		
Joiner's workshop rough	2 – 5	
Joiner's workshop fine	2 - 5	
Workshops		
Car workshop	4	
Extraction of exhaust		
Mechanical workshop		60 – 80/car
Fine mechanics		
Welding work	3 – 4	
Assembly shop	3 – 20	
Smithy	12 – 15	
	4 – 5	
	6 - 7	

Tabel 6: Guiding air amounts for each room

Once we know the air amount we can continue sizing the ducts. Depending on the size and the type of duct (main, branch, connection) the *air velocity* inside the duct will differ. This amount must be limited to prevent excessive noise caused by the air displacement.

	Recommended air velocity in m/s		
	Dwellings	Schools Offices Theatre Etc.	Industrial buildings
Main duct	3,5 – 4,5	5,0 - 6,5	6,0 – 9,0
Branch duct	3,0	3,0 – 4,5	4,0 – 5,0
Connection duct	2,5	3,0 – 3,5	4,0

Tabel 7: Recommended air velocity in different types of pipes and in diffent types of buildings

Room Number	Room Name	Location in the building	L (m)	V (m)	H (m)	A (m^2)	V (m^3)	Category	Ventilation air amount	Ventilati	Air amound m^3/s (q)	Type: Fresh/Dirty	Combined together (Room Number)	Ventilation air amount m^3/s (q) together	Air velocity (M	Duct Type	Calculated duct size (m)	Duct size	Air flow (l/s)	q_v Winter (l/s m^2)	Aggregator	Max Airflow (m^3/s)	Dimensions
Commercial area:																							
1	Café	Groundfloor (South)	15	9,5	5	142,5	712,5	A	570	4	0,158333333	Fresh	1	0,158333333	4	Branch	0,224554288	250 mm	158,3333333	1,111111111			
2	polyvalent room	Groundfloor (South)	25	10	5	250	1250	A	1000	4	0,277777778	Fresh/Dirty	2	0,277777778	6	Main	0,242050105	250 mm	277,7777778	1,111111111			
3	storage room	Groundfloor (South)	3,8	5,5	4,8	20,9	100,32	A	20,9	1	0,005805556	Dirty	2+3	0,283583333	4	Branch	0,300521486	315 mm	5,805555556	0,277777778			
4	Office	Groundfloor (North)	6,2	6,6	4,8	40,92	196,416	A	81,84	2	0,022733333	Fresh	4	0,022733333	4	branch	0,08508769	100 mm	22,73333333	0,555555556			
5	Doctors room	Groundfloor (North)	5,7	3,5	4,5	19,95	89,775	A	59,85	3	0,016625	Fresh	5	0,016625	3	Connection	0,084020521	100 mm	16,625	0,833333333			
6	Massage room 1	Groundfloor (North)	3,3	4,85	3,8	16,005	60,819	A	64,02	4	0,017783333	Fresh	6	0,017783333	3	Connection	0,08689827	100 mm	17,78333333	1,111111111			
7	Massage room 2	Groundfloor (North)	3,3	3,65	3,8	12,045	45,771	A	48,18	4	0,013383333	Fresh	7	0,013383333	3	Connection	0,075385304	100 mm	13,38333333	1,111111111			
8	Massage room 3	Groundfloor (North)	3,3	3,3	3,8	10,89	41,382	A	43,56	4	0,0121	Fresh	8	0,0121	3	Connection	0,071679873	100 mm	12,1	1,111111111			
9	Massage room 4	Groundfloor (North)	3,3	3,3	3,8	10,89	41,382	A	43,56	4	0,0121	Fresh	9	0,0121	3	Connection	0,071679873	100 mm	12,1	1,111111111			
10	Massage room 5	Groundfloor (North)	4,6	3,04	4	13,984	55,936	A	55,936	4	0,015537778	Fresh	10	0,015537778	3	connection	0,081226735	100 mm	15,53777778	1,111111111			
11	Reception	Groundfloor (North)	5,8	14,8	4,5	85,84	386,28	A	171,68	2	0,047688889	Fresh	11	0,047688889	4	Branch	0,123237755	125 mm	47,68888889	0,555555556			
12	Toilets 1	Groundfloor (North)	6,6	3,6	4,8	23,76	114,048	A	166,32	7	0,0462	Dirty	4+5+6+7+8+9+10+11+12	0,204151667	4	Branch	0,254983243	315 mm	46,2	1,944444444			
13	Toilets 2	Groundfloor (North)	2,8	4,2	2,8	11,76	32,928	A	82,32	7	0,022866667	Dirty	13	0,022866667	4	Branch	0,08533685	100 mm	22,86666667	1,944444444			
14	Toilets 3	Groundfloor (North)	2,8	8,2	2,8	22,96	64,288	A	160,72	7	0,044644444	Dirty	14	0,044644444	4	Branch	0,119239154	125 mm	44,64444444	1,944444444			
15	Changing rooms	Groundfloor (North)	3	11,6	2,8	34,8	97,44	A	313,2	9	0,087	Dirty	17+15	0,162	4	Branch	0,227139509	250 mm	87	2,5			
16	Showers	Groundfloor (North)	7	7,4	4,8	51,8	248,64	A	414,4	8	0,115111111	Dirty	17+16	0,190111111	4	Branch	0,246058814	250 mm	115,1111111	2,222222222			
17	Spa	Groundfloor (North)	13,5	20	4,8	270	1296	A	1080	4	0,3	Fresh	17	0,3	6	Main	0,252377233	315 mm	300	1,111111111			
18	Sauna 1	Groundfloor (North)	3,5	3,4	4,8	11,9	57,12	A	59,5	5	0,016527778	Dirty	17+18	0,091527778	3	connection	0,197142838	200 mm	16,52777778	1,388888889			
19	Sauna 2	Groundfloor (North)	3,5	3,7	4,8	12,95	62,16	A	64,75	5	0,017986111	Dirty	17+19	0,092986111	3	connection	0,198707192	200 mm	17,98611111	1,388888889			
20	Kitchen	Groundfloor (South)	7,5	4,8	4,8	36	172,8	A	360	10	0,1	Dirty	1+20	0,258333333	4	Branch	0,286830546	315 mm	100	2,777777778			
38	Utility shaft	north				392,5	1962,5		1570	4	0,436111111	Fresh	1+2	0,297222222	6	Main	0,251206102	315 mm	436,1111111	1,111111111			
39	Utility shaft	north				306,9	1523,12		1380,9	4	0,383583333	Dirty	2+3+20	0,383583333	6	Main	0,285377291	315 mm	383,5833333	1,249864234	VEX170H	2	2,2x1,8x0,9m
40	Utility shaft	South				480,524	1827,481		1648,626	4	0,457951667	Fresh	4+5+6+7+8+9+10+11+17	0,457951667	6	Main	0,31816698	400 mm	457,9516667	0,953025586	VEX 280-1	4	2,1x1,x1,9m
41	Utility shaft	South				169,93			1261,21	4	0,350336111	Dirty	12+13+14+15+16+18+19	0	6	Main	0,309213134	315 mm	350,3361111	2,061649568			
Student accomodation (x7):																							
21	Bathroom/toilet	first floor	2,1	3,8	3,2	7,98	25,536	A	79,8	10	0,022166667	Dirty	21+24+25	0,026879167	4	Branch	0,092176732	100 mm	22,16666667	2,777777778			
22	Kitchen	first floor (lower level)	3,8	3,75	3,9	14,25	55,575	A	142,5	10	0,039583333	Dirty	22+23+26+27	0,045145833	4	Branch	0,119906855	125 mm	39,58333333	2,777777778			
23	Dining room/living	first floor (lower level)	3,4	3,75	3,9	12,75	49,725	A	6,375	0,5	0,001770833	Fresh	23	0,001770833	3	Connection	0,027421638	100 mm	1,770833333	0,138888889			
24	Corridor/study ar	first floor (upper level)	4,5	3,2	2,7	14,4	38,88	A	7,2	0,5	0,002	Fresh	24	0,002	3	Connection	0,029142013	100 mm	2	0,138888889			
25	Entrance hall	first floor	6,7	2,7	3,2	18,09	57,888		9,045	0,5	0,0025125	Fresh	25	0,0025125	3	Connection	0,032663113	100 mm	2,5125	0,138888889			
26	Bedroom 1	first floor (upper level)	3	4,2	2,7	12,6	34,02	A	6,3	0,5	0,00175	Fresh	26	0,00175	3	Connection	0,027259857	100 mm	1,75	0,138888889			
27	Bedroom 2	first floor (upper level)	3,5	4,2	2,7	14,7	39,69	A	7,35	0,5	0,002041667	Fresh	27	0,002041667	3	Connection	0,02944401	10 mm	2,041666667	0,138888889			
42						72,54			36,27			Fresh	23+24+25+26+27	0,010075	4	Branch	0,056644494	100 mm	10,075	0,138888889			
43						22,23			222,3			Dirty	21+22	0,071825	4	Branch	0,151242203	160 mm	61,75	2,777777778			
Penthouse:																							
28	Bathroom 1	2nd floor	9,2	2,5	3,6	23	82,8	A	230	10	0,063888889	Dirty	28+33+36	0,107713889	4	Branch	0,185212813	215 mm	63,88888889	2,777777778			
29	Bathroom 2	3rd floor	3,6	2,5	3,6	9	32,4		90	10	0,025	Dirty	29+34+35	0,033289236	4	Branch	0,102964399	125 mm	139,5055556	15,50061728			
30	Bathroom 3	4th floor	3,6	2,5	3,6	9	32,4		90	10	0,025	Dirty	30+37	0,027111111	4	Branch	0,092919922	100 mm	25	2,777777778			
31	Kitchen	5th floor	7,6	2,5	3,6	19	68,4	A	190	10	0,052777778	Dirty	31+32	0,081936111	4	Branch	0,17111123	215 mm	52,77777778	2,777777778			
32	Diningroom/living	6th floor	11,3	10	3,6	113	406,8	A	56,5	0,5	0,015694444	Fresh	32	0,015694444	3	Connection	0,081635211	100 mm	15,69444444	0,138888889			
33	Study	7th floor	7,4	6,35	3,6	46,99	169,164		140,97	3	0,039158333	Fresh	33	0,039158333	3	Connection	0,128948604	160 mm	39,15833333	0,833333333			
34	Corridor	8th floor	12,15	2,55	3,6	30,9825	111,537		15,49125	0,5	0,004303125	Fresh	34	0,004303125	3	Connection	0,042746103	100 mm		0			
35	Bedroom 2	9th floor	7	4,1	3,6	28,7	103,32	A	14,35	0,5	0,003986111	Fresh	35	0,003986111	3	Connection	0,041141417	100 mm	3,986111111	0,138888889			
36	Bedroom 1	10th floor	8	4,2	3,6	33,6	120,96	A	16,8	0,5	0,004666667	Fresh	36	0,004666667	3	Connection	0,04451516	100 mm	4,666666667	0,138888889			
37	Bedroom 3	11th floor	4	3,8	3,6	15,2	54,72	A	7,6	0,5	0,002111111	Fresh	37	0,002111111	3	Connection	0,029840572	100 mm	2,111111111	0,138888889			
44						140,2725			187,61125			Fresh	33+34+35+36	0,052114236	4	Branch	0,128828919	160 mm	52,11423611	0,371521404			
45						32			320			Dirty	28+29	0,141003125	4	Branch	0,21190907	215 mm	88,88888889	2,777777778			
46						128,2			64,1			Fresh	32+37	0,017805556	4	Branch	0,075303115	100 mm	17,80555556	0,138888889			
47						28			280			Dirty	30+31	0,119047222	4	Branch	0,194712938	215 mm	77,77777778	2,777777778			
48	Utility shaft	Right wing south							450			Fresh	46+2x42	0,037955556	4	Branch	0,109944334	125 mm					
49	Utility shaft	Right wing south							2630,2			Dirty	47+2x43	0,262697222	4	Branch	0,289243039	315 mm					
50	Utility shaft	Right wing North							895,6			Fresh	44+2x42	0,072264236	4	Branch	0,151703948	160 mm					
51	Utility shaft	Right wing North							2774,22			Dirty	45+2x43	0,284653125	4	Branch	0,301087797	315 mm					
52	Utility shaft	Basement							1345,6			Fresh	48+50	0,110219792	6	Main	0,152974605	160					
53	Utility shaft	Basement							5404,42			Dirty	49+51	0,547350347	6	Main	0,340896267	400			VEX170H	2	2,2x1,8x0,9m

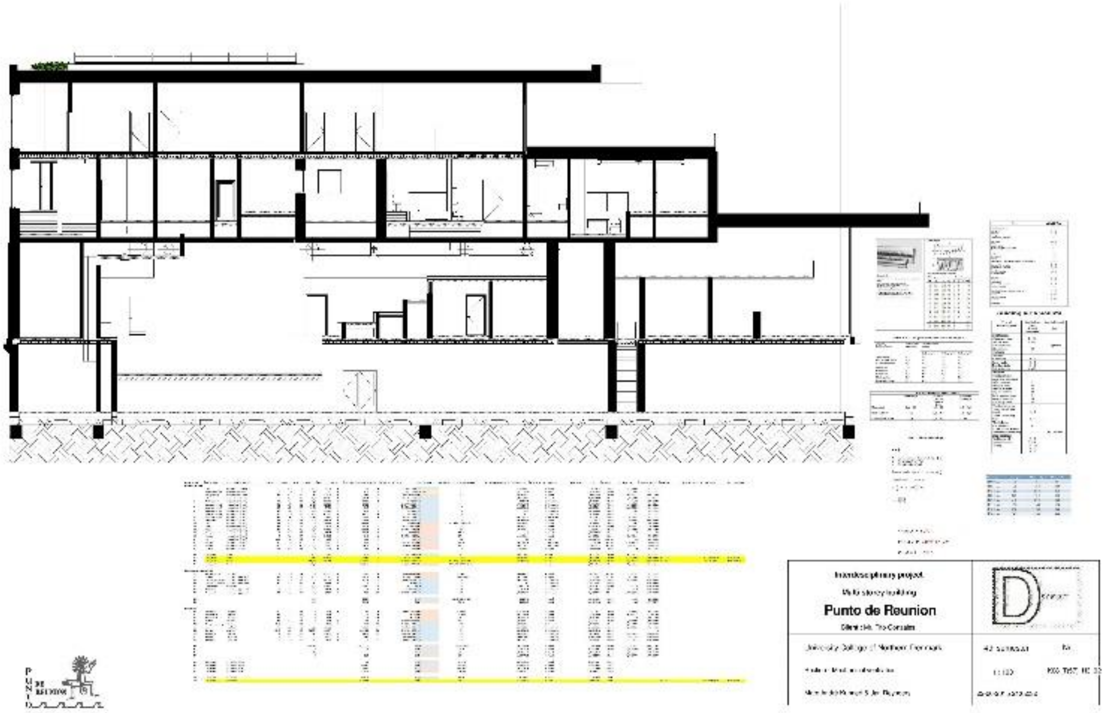
Tabel 8: Ventilation calculation and duct sizing

4.3 Ventilation section

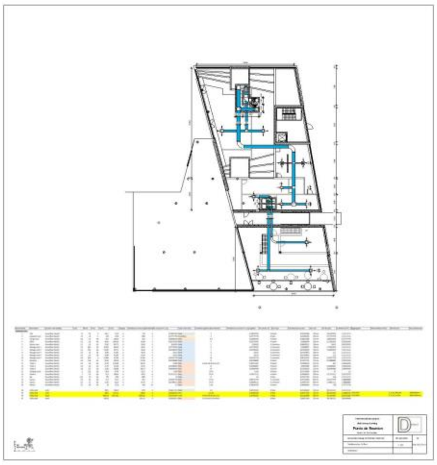
In the ventilation section we show how the different types are distributed throughout the building.

4.4 Ventilation plan

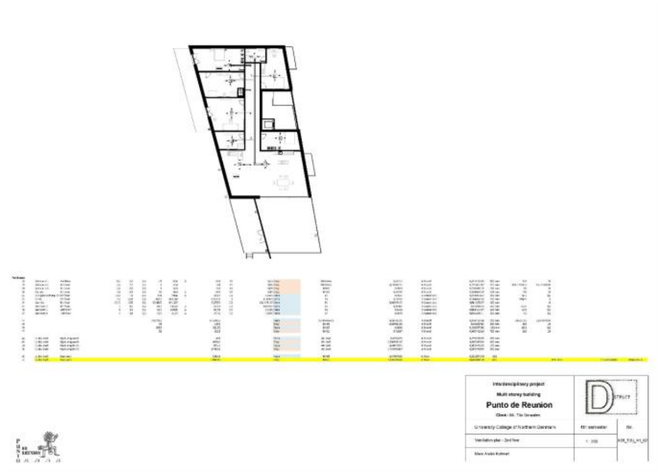
In the ventilation plan we show which rooms of a building section are supplied with fresh air and where the dirty will be extracted.



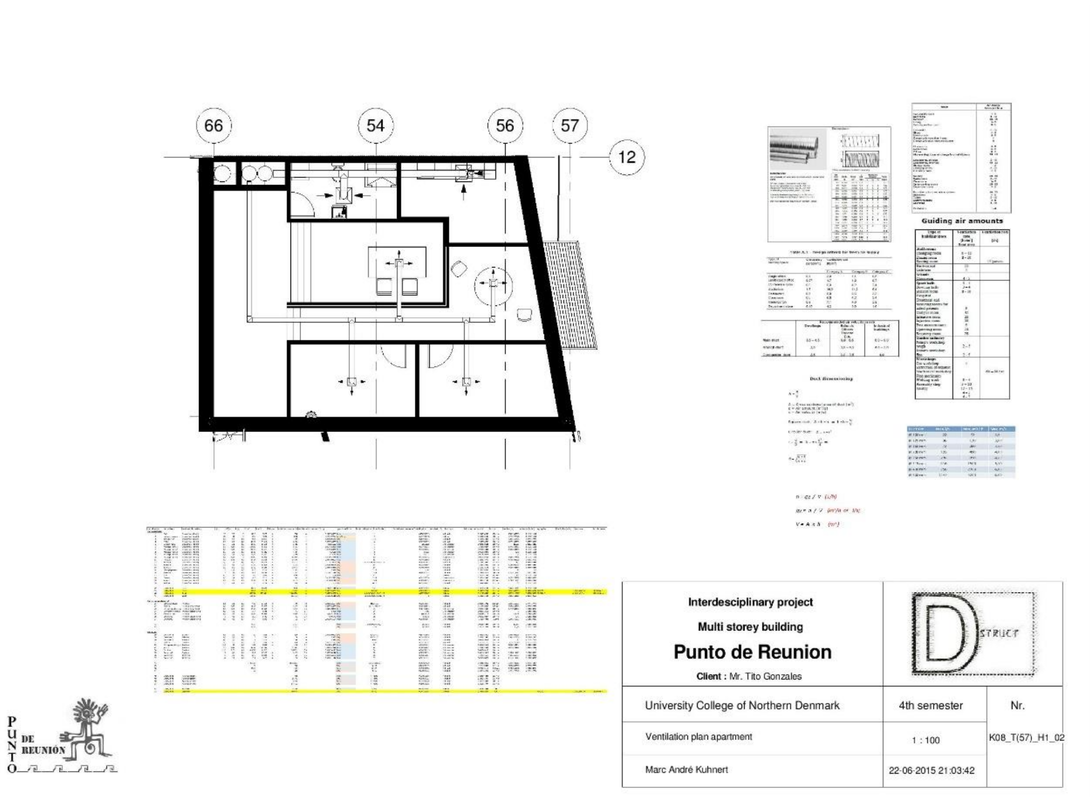
Figuur 2: Section Mechenical ventilation



Figuur 4: Mechanical ventilation groundfloor



Figuur 3: Mechanical ventilation nd floor



Figuur 5: Mechanical ventilation apartment

5. Natural ventilation

5.1 General

As main ventilation source we use *natural ventilation*. To achieve this we applied a system of stack ventilation, more specifically *Atrium ventilation.*

Atrium ventilation uses a central atrium or in our case the winter garden as its heat gain (like a greenhouse), to create the upwards airflow needed for stack ventilation.

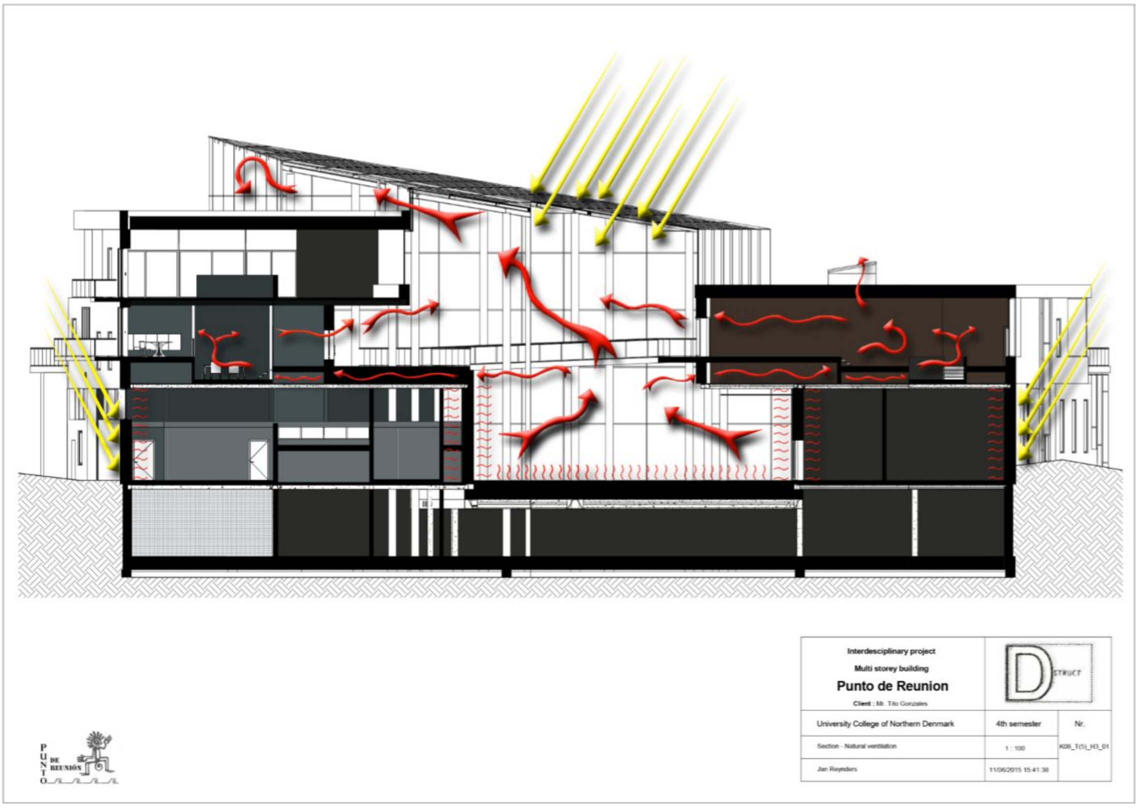
An additional benefit of this type of ventilation is that the central atrium can be used for plantation which will benefit the air quality and act as moist regulation for the building. That sort of a space can also be used as a lounge for the cafeteria and spa.

Although very beneficial, we must be aware of overheating in this during the summer time. Plants can help temper the indoor temperature, but additional measurements are needed in the form of:

- Additional (temporary) shading
- Use of thermal mass (walls, floors and soil) to better regulate the indoor temperature
- Use of heat corridors (emergency road to the winter garden, pathway through the building)

On the level of the apartments we decided to work in different levels. A lower, mid and higher level. On the lower level will have the inflow of fresh air which on its turn will gradually separate throughout the apartment and move upwards. On the highest level to exhaust of the air will take place.

5.2 Natural ventilation winter time



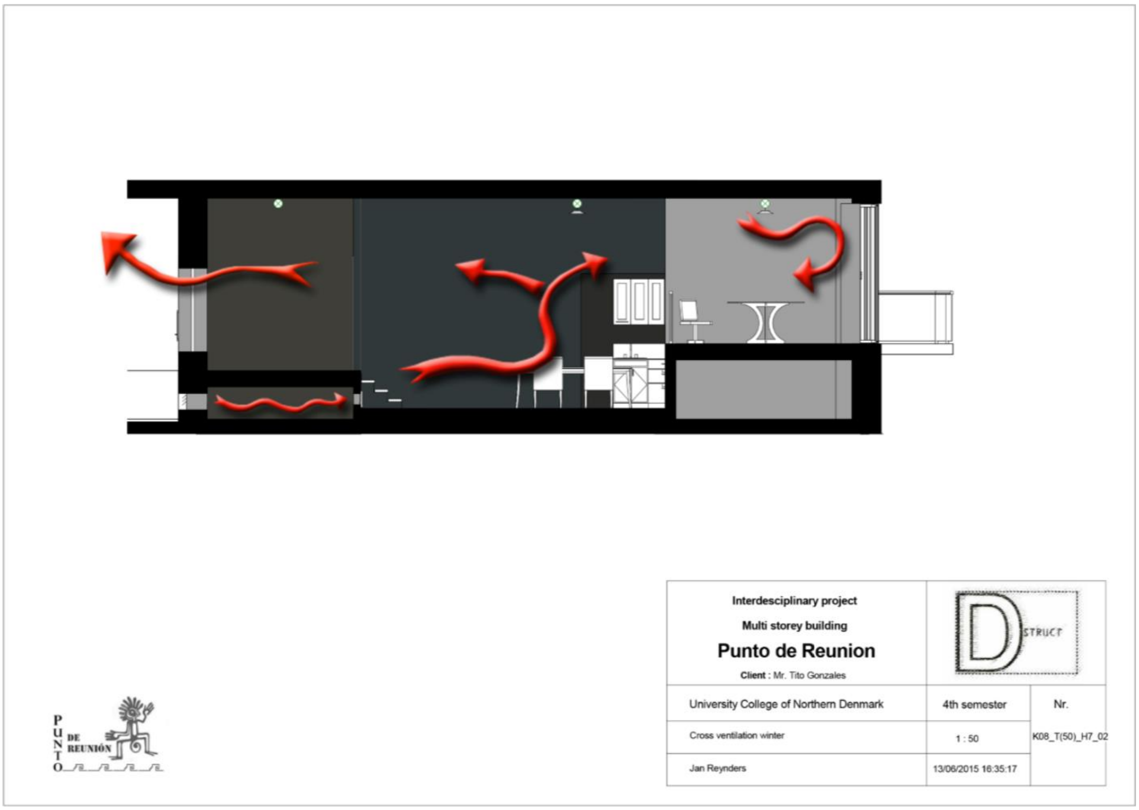
Figuur 6: Natural ventilation air flow in the building during winter time.

In winter time there is a los of solar gain due to shorter day time. The temperature will be much lower as well wich will result in even more energy loss to the surroundings. This loss will be mainly compensated by:

- Loss of shading by vegetation
- Greenhouse effect of wintergarden
- warming process of thermal mass
-* heat pump

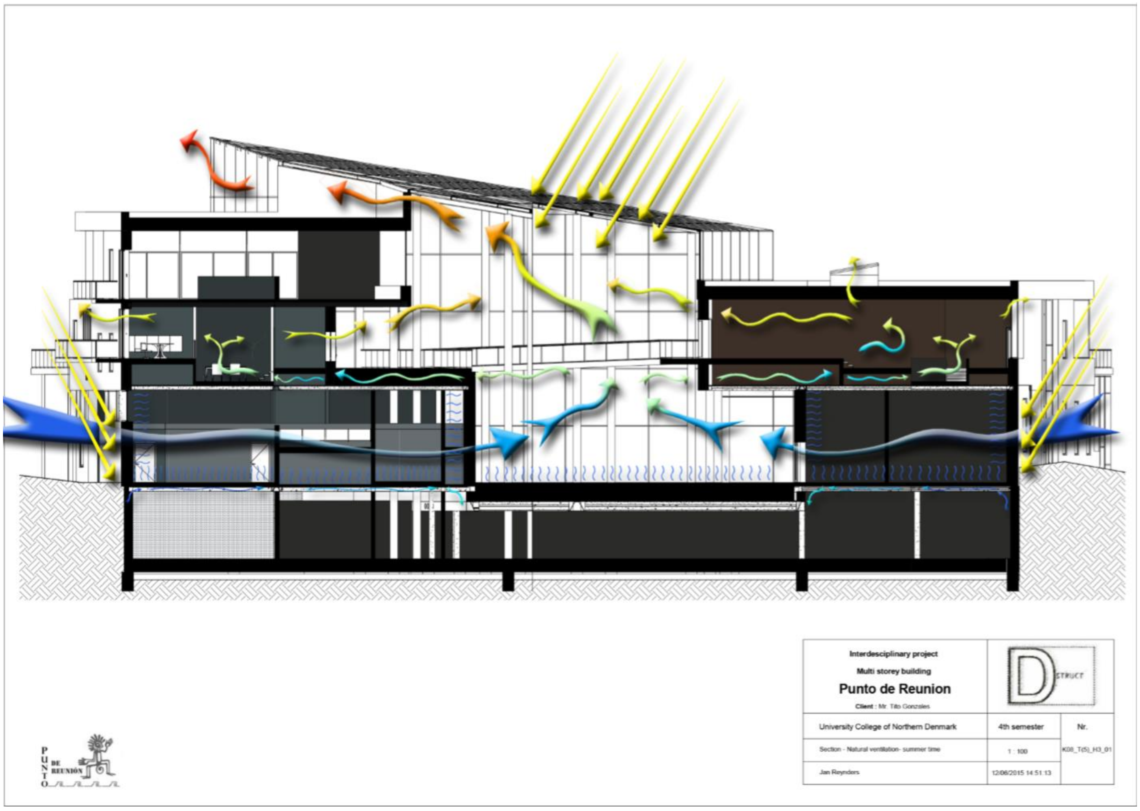
In winter time the system of natural, stack ventilation is driven by the captation of solar energy in the thermal mass present in the building (concrete and rammed earth walls, soil, concrete floor) during the day. The wintergarden will act as a green house and warm up the convection air wich on it's turn will benefit the warming process of the thermal mass. Additionally the loss of leaves of the vegetation will benifit the penetration of the solar beams into the building.

During the winter the wintergarden will be a mainly closed system to keep the warmth inside.



Figuur 7: Natural ventilation air flow in the appartment during winter time.

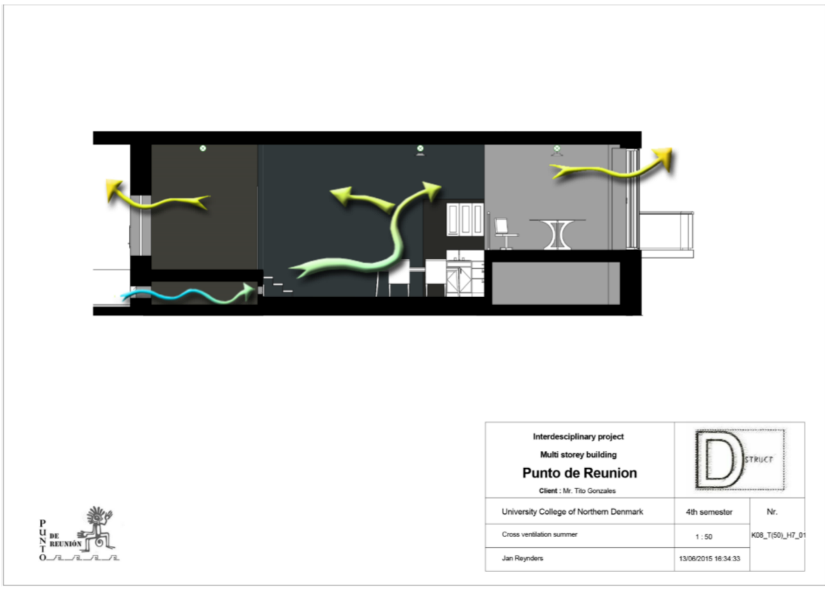
5.3 Natural ventilation summer time



During summer there is a much higher heat gain because of longer daytime, so more exposure to sunlight and higher outdoor temperatures. Now it will be our task to cool down the building in a way that we maintain a pleasant indoor air quality and prevent overheating. We will achieve this by:

- Opening the heat corridors (Pathways + wintergarden roof)
- Slab cooling by night of groundfloor by hollowcore slab
- Vegetation
- Thermal mass regulation
- * additional shading(sunblocking) of wintergarden

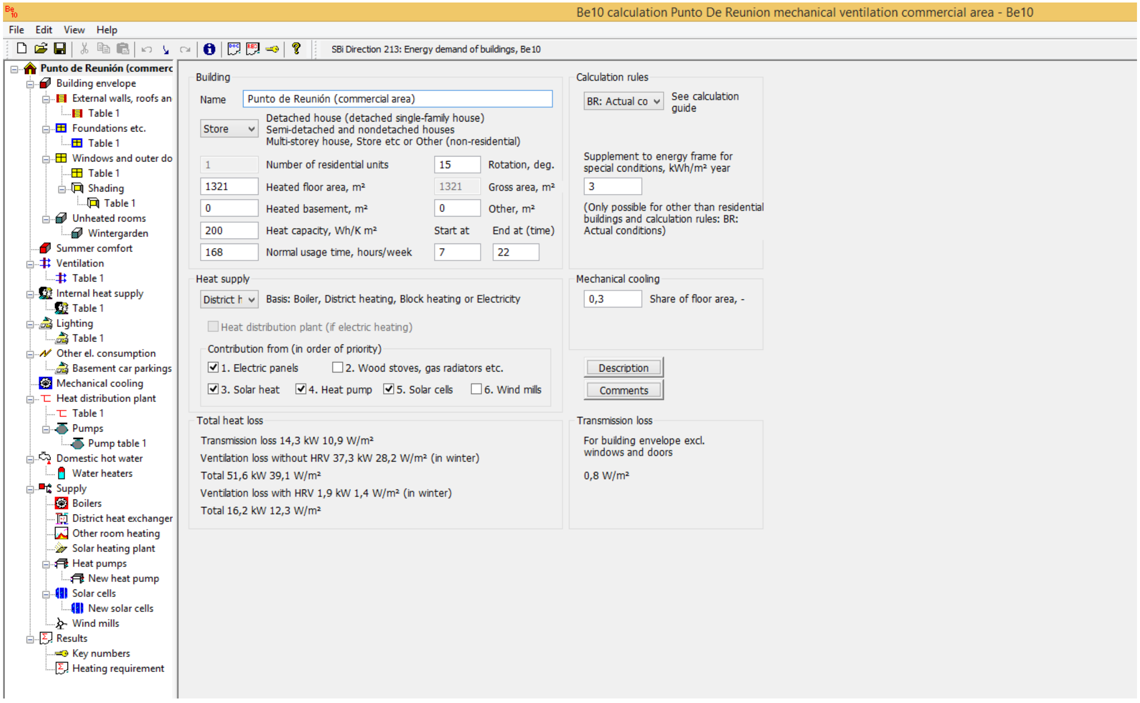
At the level of the appartements we can open the pathways for natural ventilation. But by doing so we must prevent the creating of excessive draft.



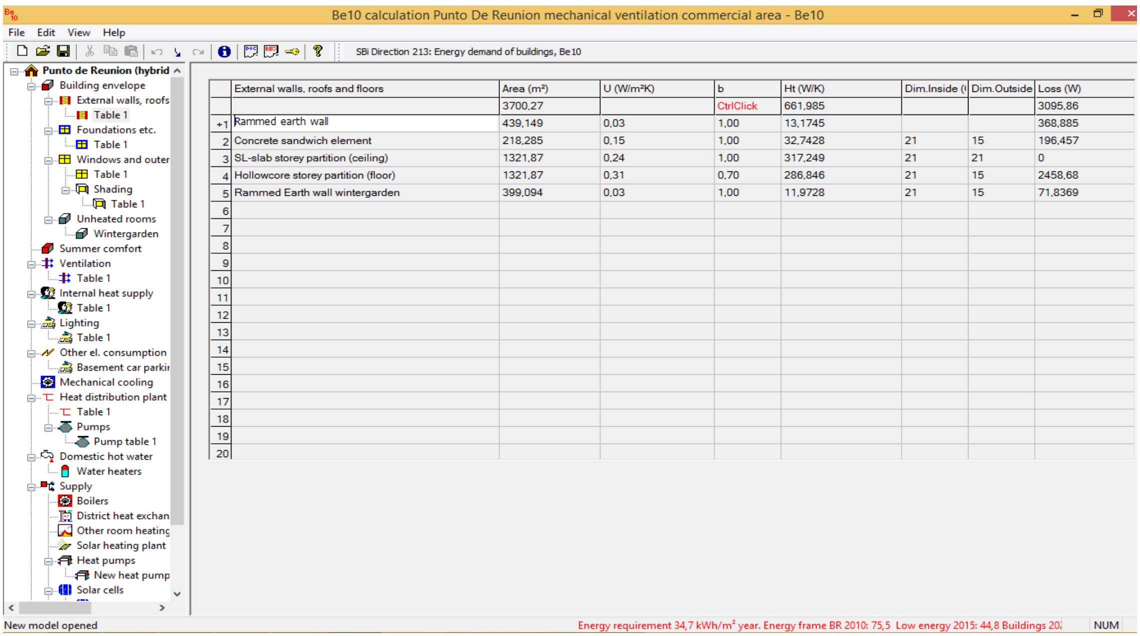
6. Be 10

The *Be10* is the final document where all the pevious steps are summarized in one calculation. Where the successice calculation was still an estimate of the energy consumption, the *Be10* calculation can give a rather accurate representation.
As we mentionned before we also have to make a seperation between commercal and student accomodation here.

6.1 Commercial area

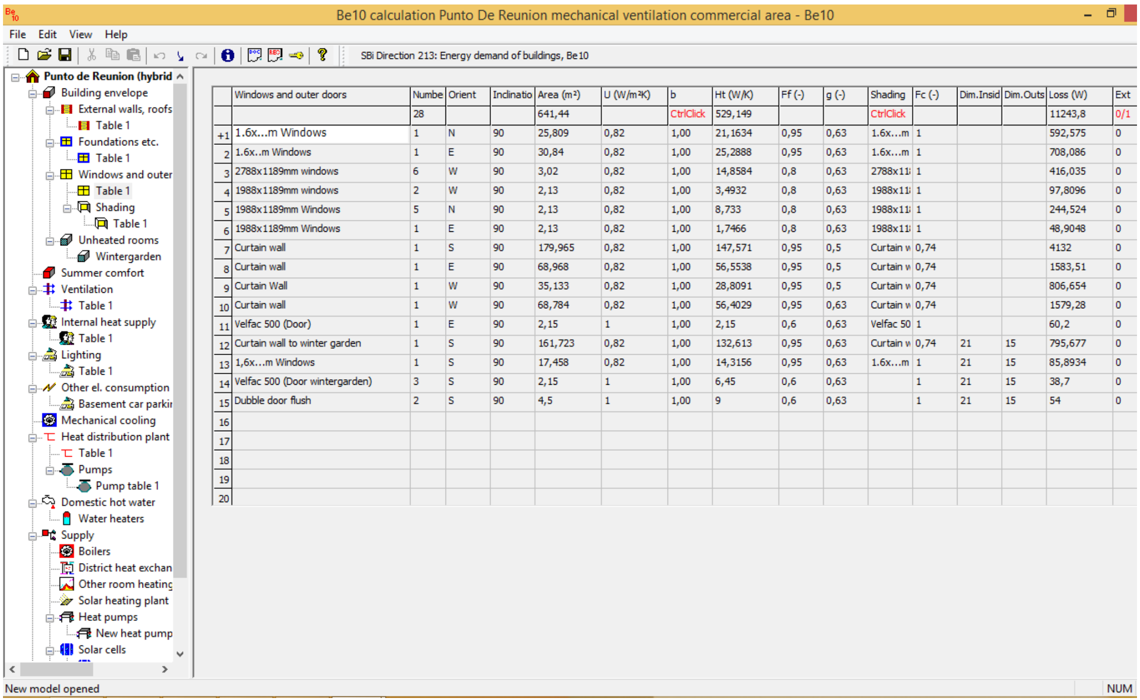


Tabel 9: Main building properties



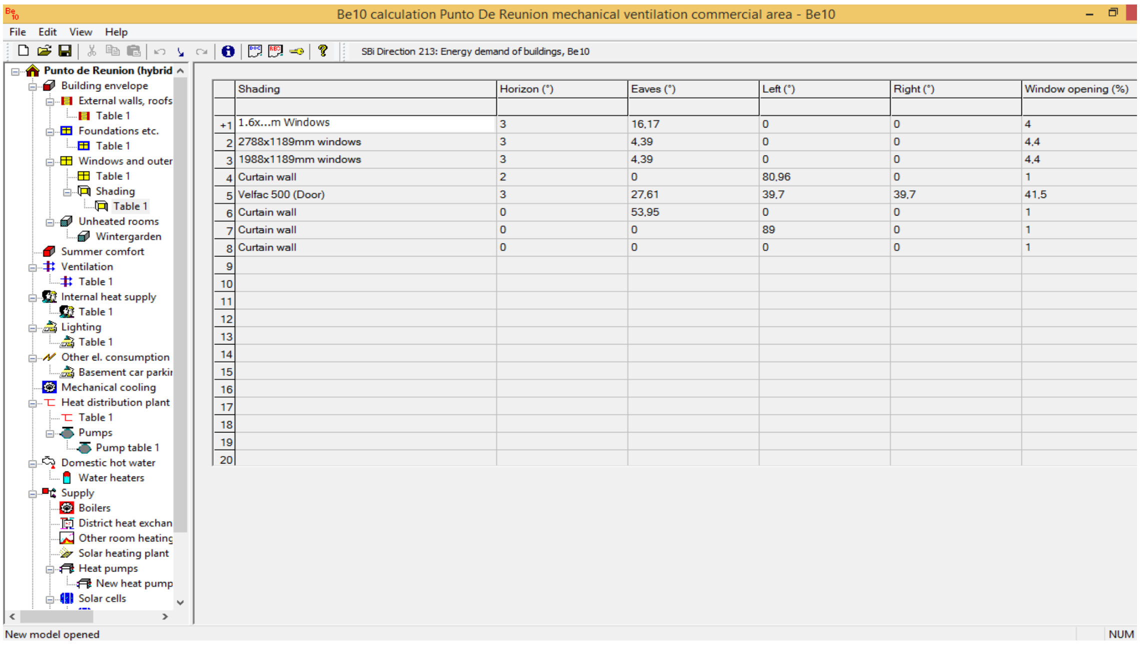
	External walls, roofs and floors	Area (m²)	U (W/m²K)	b	Ht (W/K)	Dim.Inside	Dim.Outside	Loss (W)
		3700,27		CtrlClick	661,985			3095,86
1	Rammed earth wall	439,149	0,03	1,00	13,1745			368,885
2	Concrete sandwich element	218,285	0,15	1,00	32,7428	21	15	196,457
3	SL-slab storey partition (ceiling)	1321,87	0,24	1,00	317,249	21	21	0
4	Hollowcore storey partition (floor)	1321,87	0,31	0,70	286,846	21	15	2458,68
5	Rammed Earth wall wintergarden	399,094	0,03	1,00	11,9728	21	15	71,8369

Tabel 10: Overview external walls, roofs and floors



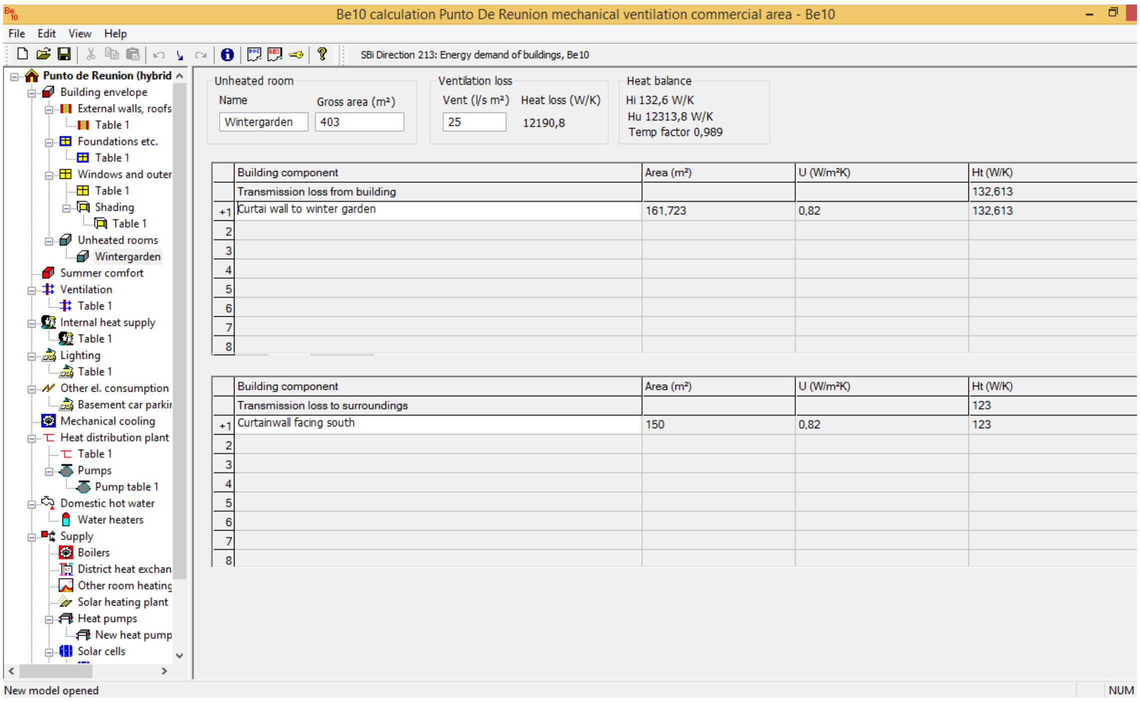
	Windows and outer doors	Numbe	Orient	Inclinatio	Area (m²)	U (W/m²K)	b	Ht (W/K)	Ff (-)	g (-)	Shading	Fc (-)	Dim.Insid	Dim.Outs	Loss (W)	Ext
		28			641,44		CtrlClick	529,149			CtrlClick				11243,8	0/1
+1	1.6x...m Windows	1	N	90	25,809	0,82	1,00	21,1634	0,95	0,63	1.6x...m	1			592,575	0
2	1.6x..m Windows	1	E	90	30,84	0,82	1,00	25,2888	0,95	0,63	1.6x...m	1			708,086	0
3	2788x1189mm windows	6	W	90	3,02	0,82	1,00	14,8584	0,8	0,63	2788x11	1			416,035	0
4	1988x1189mm windows	2	W	90	2,13	0,82	1,00	3,4932	0,8	0,63	1988x11	1			97,8096	0
5	1988x1189mm Windows	5	N	90	2,13	0,82	1,00	8,733	0,8	0,63	1988x11	1			244,524	0
6	1988x1189mm Windows	1	E	90	2,13	0,82	1,00	1,7466	0,8	0,63	1988x11	1			48,9048	0
7	Curtain wall	1	S	90	179,965	0,82	1,00	147,571	0,95	0,5	Curtain w	0,74			4132	0
8	Curtain wall	1	E	90	68,968	0,82	1,00	56,5538	0,95	0,5	Curtain w	0,74			1583,51	0
9	Curtain Wall	1	W	90	35,133	0,82	1,00	28,8091	0,95	0,5	Curtain w	0,74			806,654	0
10	Curtain wall	1	W	90	68,784	0,82	1,00	56,4029	0,95	0,63	Curtain w	0,74			1579,28	0
11	Velfac 500 (Door)	1	E	90	2,15	1	1,00	2,15	0,6	0,63	Velfac 50	1			60,2	0
12	Curtain wall to winter garden	1	S	90	161,723	0,82	1,00	132,613	0,95	0,63	Curtain w	0,74	21	15	795,677	0
13	1,6x...m Windows	1	S	90	17,458	0,82	1,00	14,3156	0,95	0,63	1.6x...m	1	21	15	85,8934	0
14	Velfac 500 (Door wintergarden)	3	S	90	2,15	1	1,00	6,45	0,6	0,63		1	21	15	38,7	0
15	Dubble door flush	2	S	90	4,5	1	1,00	9	0,6	0,63		1	21	15	54	0

Tabel 12: overview of glased areas and outer doors



	Shading	Horizon (°)	Eaves (°)	Left (°)	Right (°)	Window opening (%)
+1	1.6x...m Windows	3	16,17	0	0	4
2	2788x1189mm windows	3	4,39	0	0	4,4
3	1988x1189mm windows	3	4,39	0	0	4,4
4	Curtain wall	2	0	80,96	0	1
5	Velfac 500 (Door)	3	27,61	39,7	39,7	41,5
6	Curtain wall	0	53,95	0	0	1
7	Curtain wall	0	0	89	0	1
8	Curtain wall	0	0	0	0	1

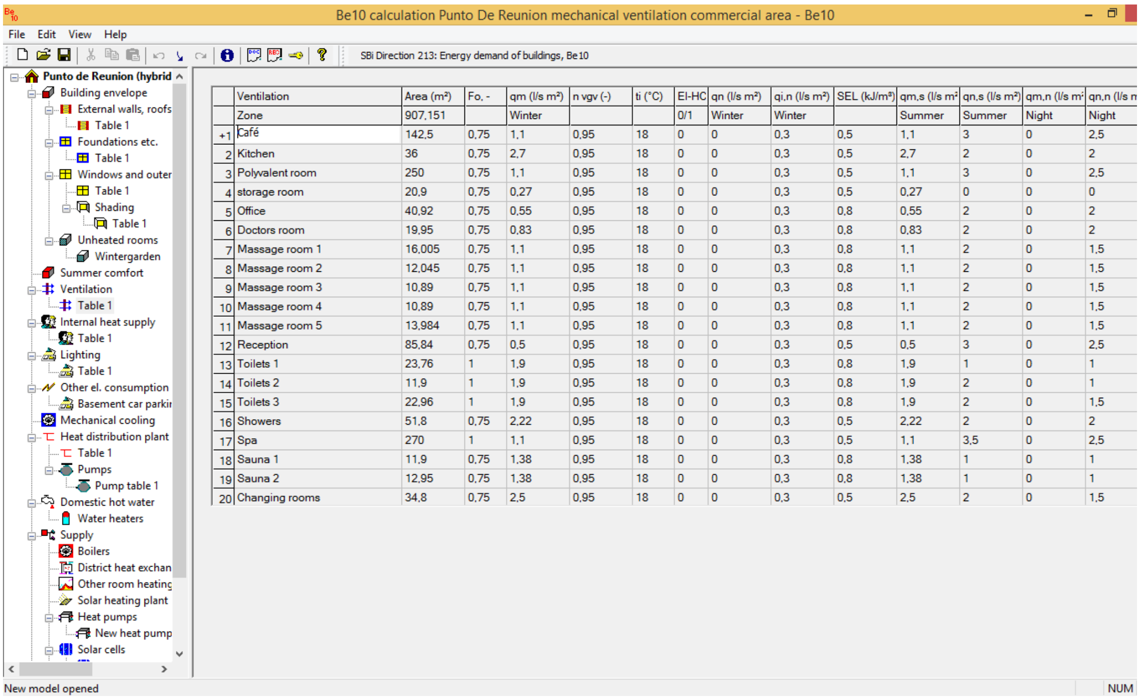
Tabel 11: Overview of shading by overhang, sun orientation, window opening



	Building component	Area (m²)	U (W/m²K)	Ht (W/K)
	Transmission loss from building			132,613
+1	Curtai wall to winter garden	161,723	0,82	132,613
2				
3				
4				
5				
6				
7				
8				

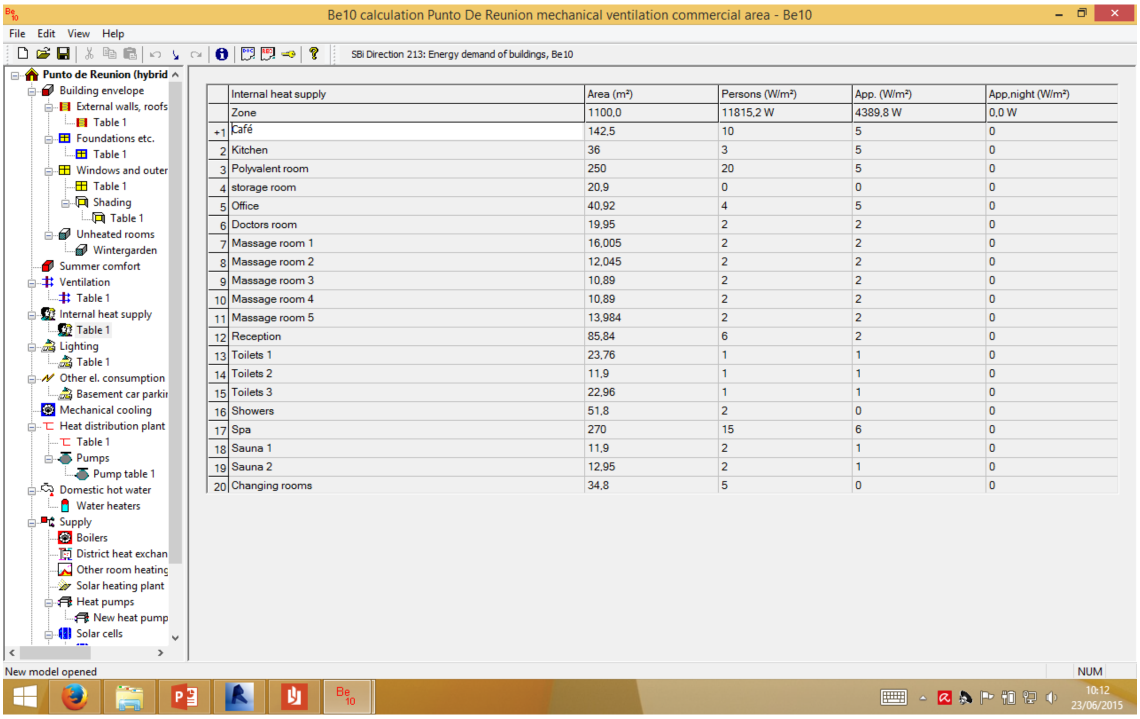
	Building component	Area (m²)	U (W/m²K)	Ht (W/K)
	Transmission loss to surroundings			123
+1	Curtainwall facing south	150	0,82	123
2				
3				
4				
5				
6				
7				
8				

Tabel 14: Unheated rooms



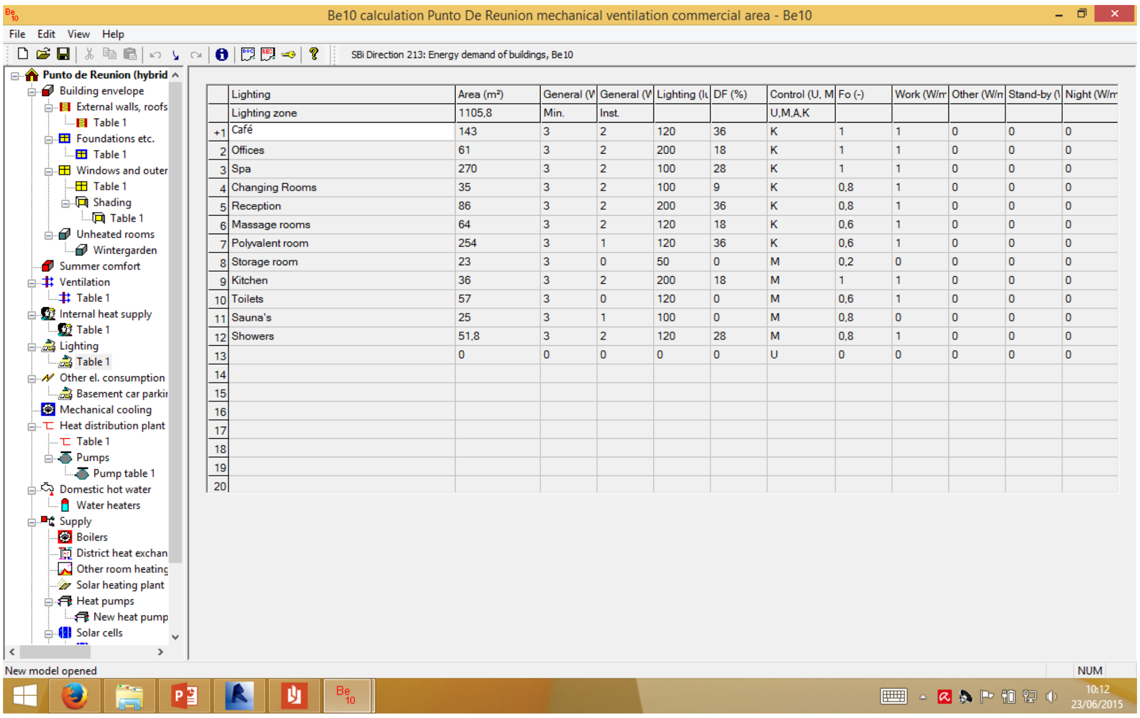
	Ventilation	Area (m²)	Fo, -	qm (l/s m²)	n vgv (-)	ti (°C)	El-HC	qn (l/s m²)	qi,n (l/s m²)	SEL (kJ/m³)	qm,s (l/s m²	qn,s (l/s m²)	qm,n (l/s m²	qn,n (l/s m
	Zone	907,151		Winter			0/1	Winter	Winter		Summer	Summer	Night	Night
+1	Café	142,5	0,75	1,1	0,95	18	0	0	0,3	0,5	1,1	3	0	2,5
2	Kitchen	36	0,75	2,7	0,95	18	0	0	0,3	0,5	2,7	2	0	2
3	Polyvalent room	250	0,75	1,1	0,95	18	0	0	0,3	0,5	1,1	3	0	2,5
4	storage room	20,9	0,75	0,27	0,95	18	0	0	0,3	0,5	0,27	0	0	0
5	Office	40,92	0,75	0,55	0,95	18	0	0	0,3	0,8	0,55	2	0	2
6	Doctors room	19,95	0,75	0,83	0,95	18	0	0	0,3	0,8	0,83	2	0	2
7	Massage room 1	16,005	0,75	1,1	0,95	18	0	0	0,3	0,8	1,1	2	0	1,5
8	Massage room 2	12,045	0,75	1,1	0,95	18	0	0	0,3	0,8	1,1	2	0	1,5
9	Massage room 3	10,89	0,75	1,1	0,95	18	0	0	0,3	0,8	1,1	2	0	1,5
10	Massage room 4	10,89	0,75	1,1	0,95	18	0	0	0,3	0,8	1,1	2	0	1,5
11	Massage room 5	13,984	0,75	1,1	0,95	18	0	0	0,3	0,8	1,1	2	0	1,5
12	Reception	85,84	0,75	0,5	0,95	18	0	0	0,3	0,5	0,5	3	0	2,5
13	Toilets 1	23,76	1	1,9	0,95	18	0	0	0,3	0,8	1,9	1	0	1
14	Toilets 2	11,9	1	1,9	0,95	18	0	0	0,3	0,8	1,9	2	0	1
15	Toilets 3	22,96	1	1,9	0,95	18	0	0	0,3	0,8	1,9	2	0	1,5
16	Showers	51,8	0,75	2,22	0,95	18	0	0	0,3	0,5	2,22	2	0	2
17	Spa	270	1	1,1	0,95	18	0	0	0,3	0,5	1,1	3,5	0	2,5
18	Sauna 1	11,9	0,75	1,38	0,95	18	0	0	0,3	0,8	1,38	1	0	1
19	Sauna 2	12,95	0,75	1,38	0,95	18	0	0	0,3	0,8	1,38	1	0	1
20	Changing rooms	34,8	0,75	2,5	0,95	18	0	0	0,3	0,5	2,5	2	0	1,5

Tabel 13: Ventilation calculation



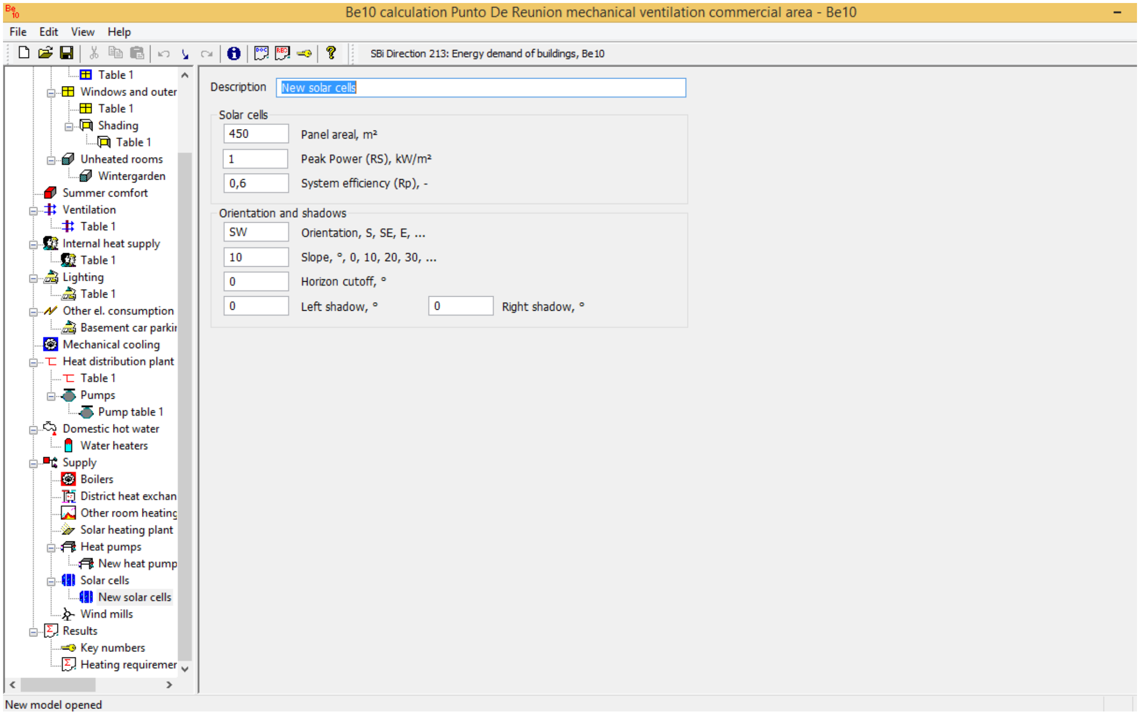
	Internal heat supply	Area (m²)	Persons (W/m²)	App. (W/m²)	App.night (W/m²)
	Zone	1100,0	11815,2 W	4389,8 W	0,0 W
+1	Café	142,5	10	5	0
2	Kitchen	36	3	5	0
3	Polyvalent room	250	20	5	0
4	storage room	20,9	0	0	0
5	Office	40,92	4	5	0
6	Doctors room	19,95	2	2	0
7	Massage room 1	16,005	2	2	0
8	Massage room 2	12,045	2	2	0
9	Massage room 3	10,89	2	2	0
10	Massage room 4	10,89	2	2	0
11	Massage room 5	13,984	2	2	0
12	Reception	85,84	6	2	0
13	Toilets 1	23,76	1	1	0
14	Toilets 2	11,9	1	1	0
15	Toilets 3	22,96	1	1	0
16	Showers	51,8	2	0	0
17	Spa	270	15	6	0
18	Sauna 1	11,9	2	1	0
19	Sauna 2	12,95	2	1	0
20	Changing rooms	34,8	5	0	0

Tabel 15: Internal heat gain

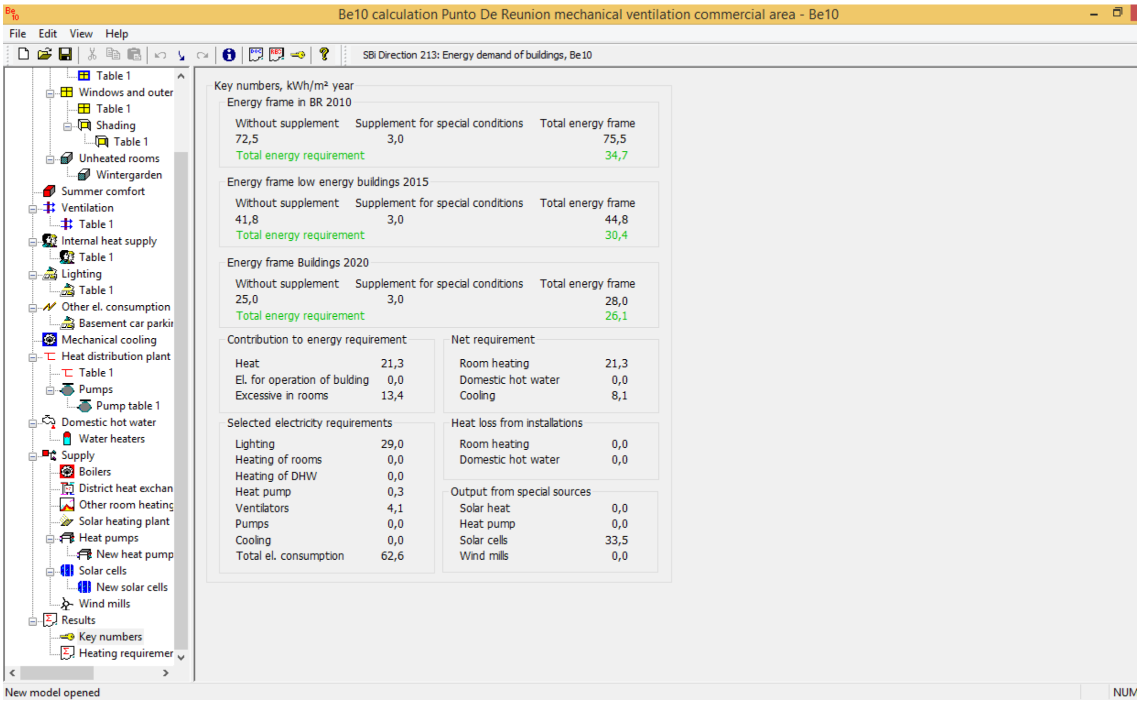


	Lighting	Area (m²)	General (W	General (W	Lighting (lu	DF (%)	Control (U, M	Fo (-)	Work (W/m	Other (W/m	Stand-by (\	Night (W/m
	Lighting zone	1105,8	Min.	Inst.			U,M,A,K					
+1	Café	143	3	2	120	36	K	1	1	0	0	0
2	Offices	61	3	2	200	18	K	1	1	0	0	0
3	Spa	270	3	2	100	28	K	1	1	0	0	0
4	Changing Rooms	35	3	2	100	9	K	0,8	1	0	0	0
5	Reception	86	3	2	200	36	K	0,8	1	0	0	0
6	Massage rooms	64	3	2	120	18	K	0,6	1	0	0	0
7	Polyvalent room	254	3	1	120	36	K	0,6	1	0	0	0
8	Storage room	23	3	0	50	0	M	0,2	0	0	0	0
9	Kitchen	36	3	2	200	18	M	1	1	0	0	0
10	Toilets	57	3	0	120	0	M	0,6	1	0	0	0
11	Sauna's	25	3	1	100	0	M	0,8	0	0	0	0
12	Showers	51,8	3	2	120	28	M	0,8	1	0	0	0
13		0	0	0	0	0	U	0	0	0	0	0
14												
15												
16												
17												
18												
19												
20												

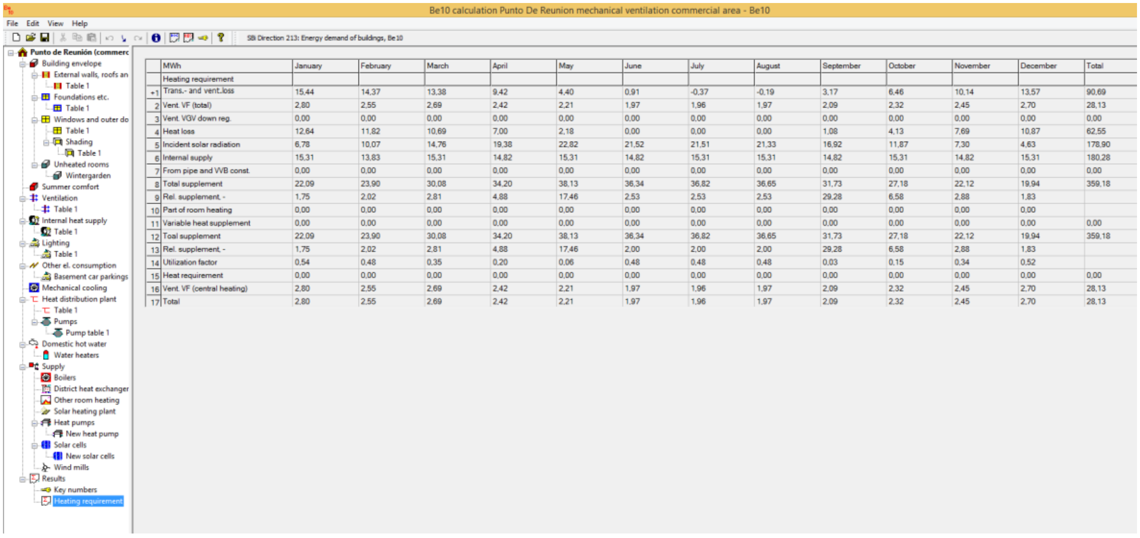
Tabel 16: overview lighting per room



Tabel 18: Additional supply solar cells (incoporated in roof winter garden)



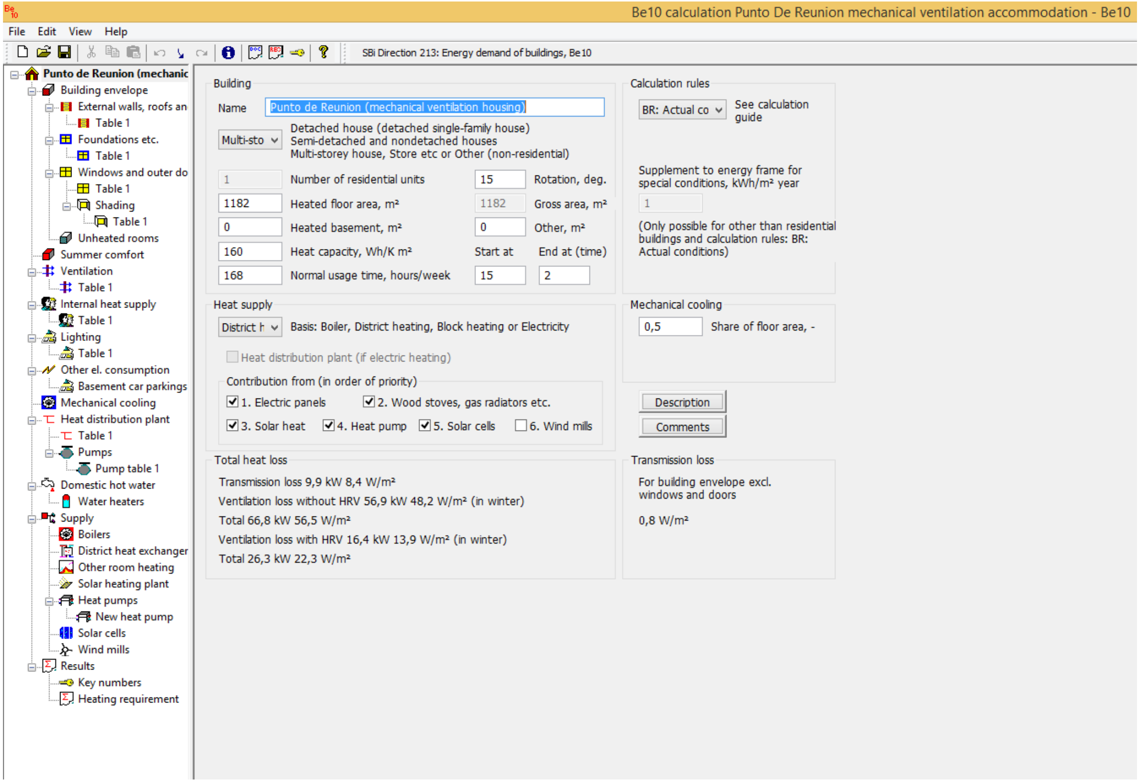
Tabel 17: Overview energy requirements and key numbers



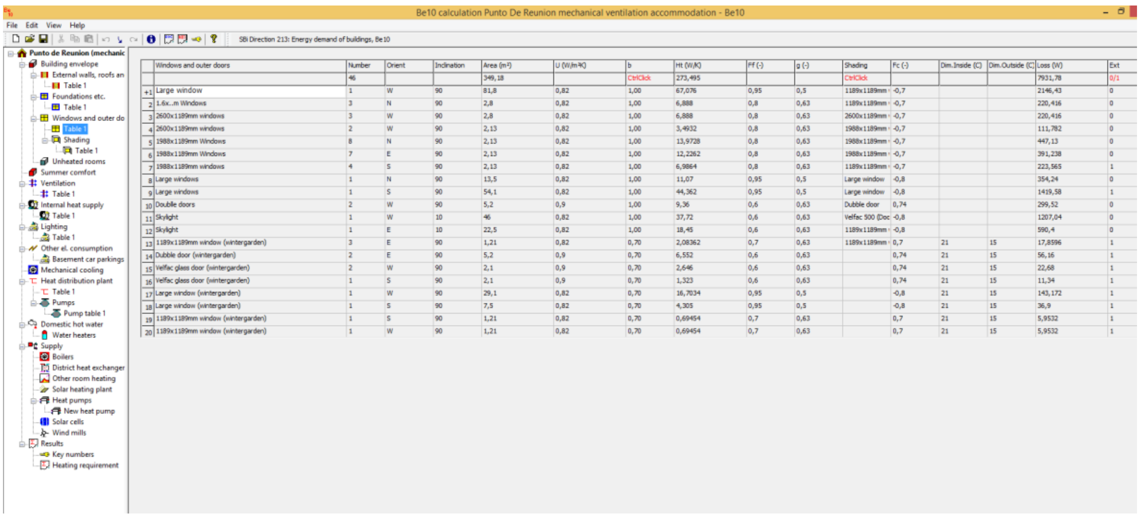
	MWh	January	February	March	April	May	June	July	August	September	October	November	December	Total
	Heating requirement													
+1	Trans.- and vent.loss	15,44	14,37	13,38	9,42	4,40	0,91	-0,37	-0,19	3,17	6,46	10,14	13,57	90,69
2	Vent. VF (total)	2,80	2,55	2,69	2,42	2,21	1,97	1,96	1,97	2,09	2,32	2,45	2,70	28,13
3	Vent. VGV down reg.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4	Heat loss	12,64	11,82	10,69	7,00	2,18	0,00	0,00	0,00	1,08	4,13	7,69	10,87	62,55
5	Incident solar radiation	6,78	10,07	14,76	19,38	22,82	21,52	21,51	21,33	16,92	11,87	7,30	4,63	178,90
6	Internal supply	15,31	13,83	15,31	14,82	15,31	14,82	15,31	15,31	14,82	15,31	14,82	15,31	180,28
7	From pipe and VVB const.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
8	Total supplement	22,09	23,90	30,08	34,20	38,13	36,34	36,82	36,65	31,73	27,18	22,12	19,94	359,18
9	Rel. supplement. -	1,75	2,02	2,81	4,88	17,46	2,53	2,53	2,53	29,28	6,58	2,88	1,83	
10	Part of room heating	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
11	Variable heat supplement	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
12	Toal supplement	22,09	23,90	30,08	34,20	38,13	36,34	36,82	36,65	31,73	27,18	22,12	19,94	359,18
13	Rel. supplement. -	1,75	2,02	2,81	4,88	17,46	2,00	2,00	2,00	29,28	6,58	2,88	1,83	
14	Utilization factor	0,54	0,48	0,35	0,20	0,06	0,48	0,48	0,48	0,03	0,15	0,34	0,52	
15	Heat requirement	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
16	Vent. VF (central heating)	2,80	2,55	2,69	2,42	2,21	1,97	1,96	1,97	2,09	2,32	2,45	2,70	28,13
17	Total	2,80	2,55	2,69	2,42	2,21	1,97	1,96	1,97	2,09	2,32	2,45	2,70	28,13

Tabel 19: Overview heating requirements

6.2 Student accomodation

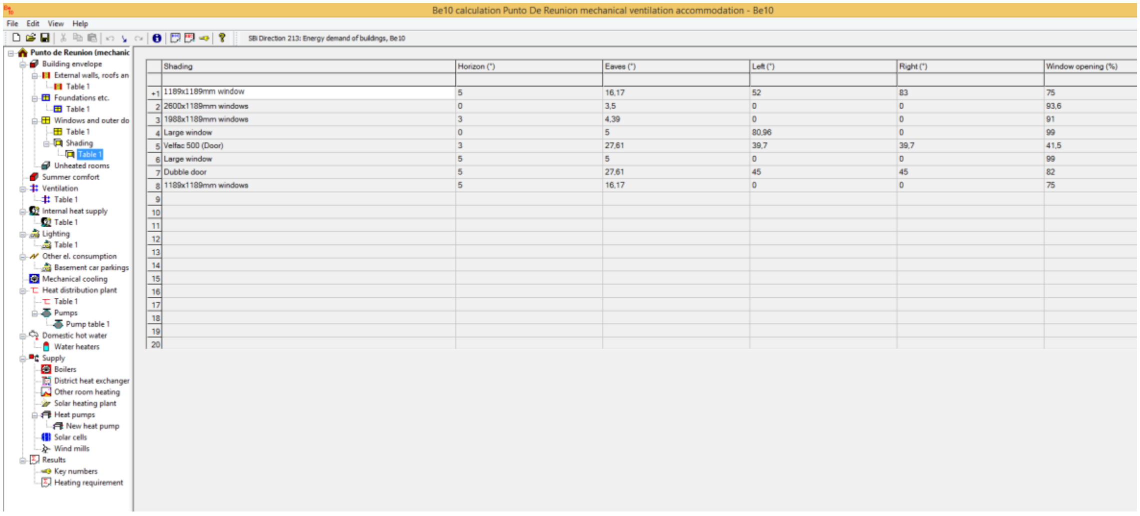


Tabel 21: overview building properties



	Windows and outer doors	Number	Orient	Inclination	Area (m²)	U (W/m²K)	b	Ht (W/K)	Ff (-)	g (-)	Shading	Fc (-)	Dim.Inside (C)	Dim.Outside (C)	Loss (W)	Ext
		46			349,18		CtrlClick	273,495			CtrlClick				7931,78	0/1
+1	Large window	1	W	90	81,8	0,82	1,00	67,076	0,95	0,5	1189x1189mm	-0,7			2146,43	0
2	1.6x..m Windows	3	N	90	2,8	0,82	1,00	6,888	0,8	0,63	1189x1189mm	-0,7			220,416	0
3	2600x1189mm windows	3	W	90	2,8	0,82	1,00	6,888	0,8	0,63	2600x1189mm	-0,7			220,416	0
4	2600x1189mm windows	2	W	90	2,13	0,82	1,00	3,4932	0,8	0,63	1988x1189mm	-0,7			111,782	0
5	1988x1189mm Windows	8	N	90	2,13	0,82	1,00	13,9728	0,8	0,63	1988x1189mm	-0,7			447,13	0
6	1988x1189mm Windows	7	E	90	2,13	0,82	1,00	12,2262	0,8	0,63	1988x1189mm	-0,7			391,238	0
7	1988x1189mm windows	4	S	90	2,13	0,82	1,00	6,9864	0,8	0,63	1189x1189mm	-0,7			223,565	1
8	Large windows	1	N	90	13,5	0,82	1,00	11,07	0,95	0,5	Large window	-0,8			354,24	0
9	Large windows	1	S	90	54,1	0,82	1,00	44,362	0,95	0,5	Large window	-0,8			1419,58	1
10	Double doors	2	W	90	5,2	0,9	1,00	9,36	0,6	0,63	Dubble door	0,74			299,52	0
11	Skylight	1	W	10	46	0,82	1,00	37,72	0,6	0,63	Velfac 500 (Doc	-0,8			1207,04	0
12	Skylight	1	E	10	22,5	0,82	1,00	18,45	0,6	0,63	1189x1189mm	-0,8			590,4	0
13	1189x1189mm window (wintergarden)	3	E	90	1,21	0,82	0,70	2,08362	0,7	0,63	1189x1189mm	0,7	21	15	17,8596	1
14	Dubble door (wintergarden)	2	E	90	5,2	0,9	0,70	6,552	0,6	0,63		0,74	21	15	56,16	1
15	Velfac glass door (wintergarden)	2	W	90	2,1	0,9	0,70	2,646	0,6	0,63		0,74	21	15	22,68	1
16	Velfac glass door (wintergarden)	1	S	90	2,1	0,9	0,70	1,323	0,6	0,63		0,74	21	15	11,34	1
17	Large window (wintergarden)	1	W	90	29,1	0,82	0,70	16,7034	0,95	0,5		-0,8	21	15	143,172	1
18	Large window (wintergarden)	1	S	90	7,5	0,82	0,70	4,305	0,95	0,5		-0,8	21	15	36,9	1
19	1189x1189mm window (wintergarden)	1	S	90	1,21	0,82	0,70	0,69454	0,7	0,63		0,7	21	15	5,9532	1
20	1189x1189mm window (wintergarden)	1	W	90	1,21	0,82	0,70	0,69454	0,7	0,63		0,7	21	15	5,9532	1

Tabel 20: Overview properties of exterior walls, roofs and floors

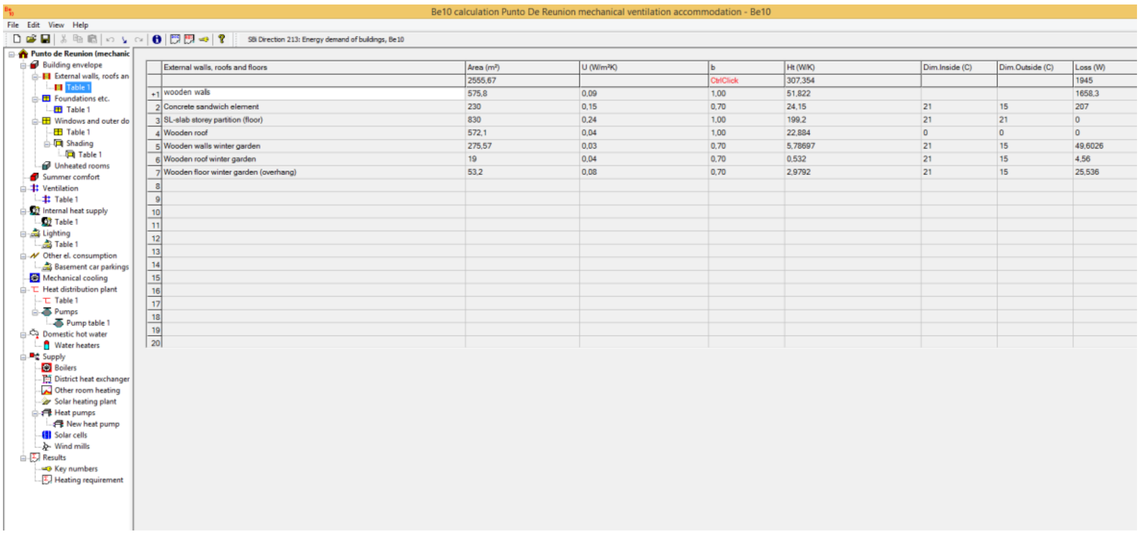


Be10 calculation Punto De Reunion mechanical ventilation accommodation - Be10

SBi Direction 213: Energy demand of buildings, Be10

	Shading	Horizon (°)	Eaves (°)	Left (°)	Right (°)	Window opening (%)
+1	1189x1189mm window	5	16,17	52	83	75
2	2600x1189mm windows	0	3,5	0	0	93,6
3	1988x1189mm windows	3	4,39	0	0	91
4	Large window	0	5	80,96	0	99
5	Velfac 500 (Door)	3	27,61	39,7	39,7	41,5
6	Large window	5	5	0	0	99
7	Dubble door	5	27,61	45	45	82
8	1189x1189mm windows	5	16,17	0	0	75

Tabel 23: Overview properties of glased areas and doors.



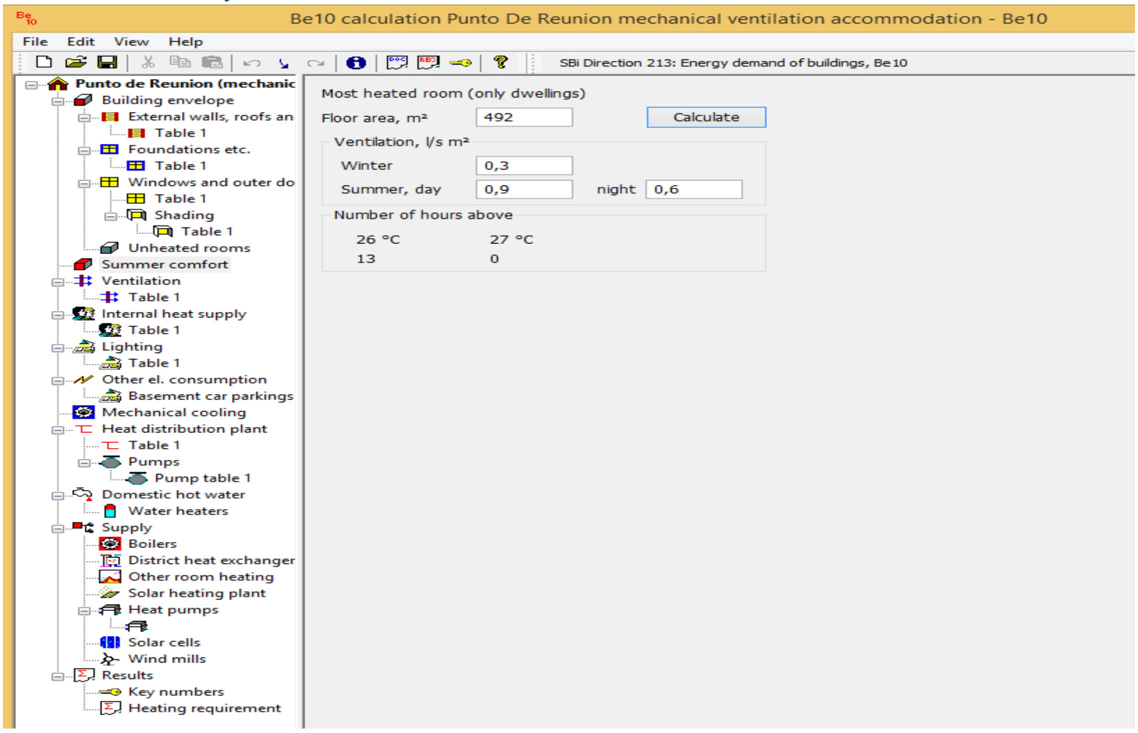
Be10 calculation Punto De Reunion mechanical ventilation accommodation - Be10

SBi Direction 213: Energy demand of buildings, Be10

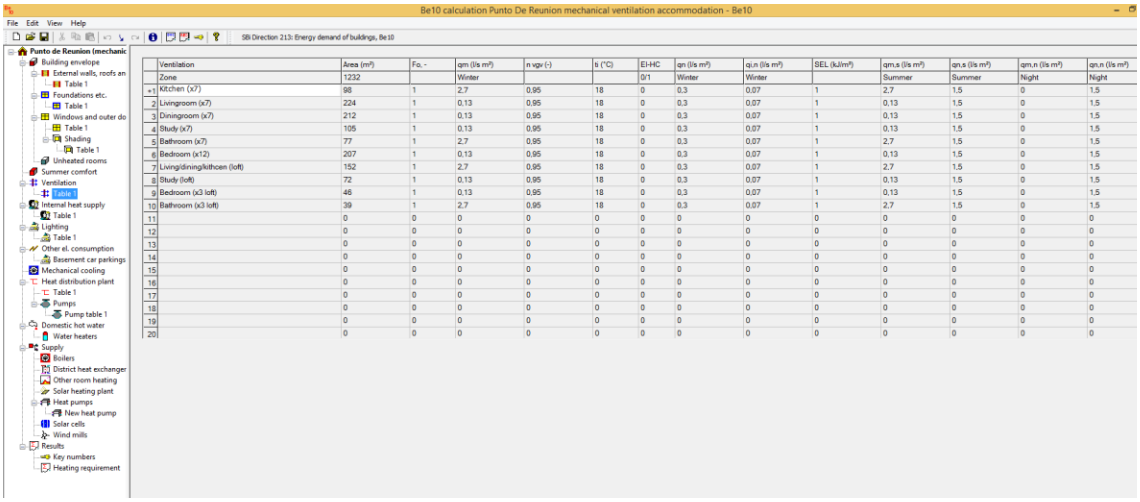
	External walls, roofs and floors	Area (m²)	U (W/m²K)	b	Ht (W/K)	Dim.Inside (C)	Dim.Outside (C)	Loss (W)
		2555,67		CtrlClick	307,354			1945
+1	wooden walls	575,8	0,09	1,00	51,822			1658,3
2	Concrete sandwich element	230	0,15	0,70	24,15	21	15	207
3	SL-slab storey partition (floor)	830	0,24	1,00	199,2	21	21	0
4	Wooden roof	572,1	0,04	1,00	22,884	0	0	0
5	Wooden walls winter garden	275,57	0,03	0,70	5,78697	21	15	49,6026
6	Wooden roof winter garden	19	0,04	0,70	0,532	21	15	4,56
7	Wooden floor winter garden (overhang)	53,2	0,08	0,70	2,9792	21	15	25,536

Tabel 22: overview of shading

Tabel 24: Summer comfort calculation

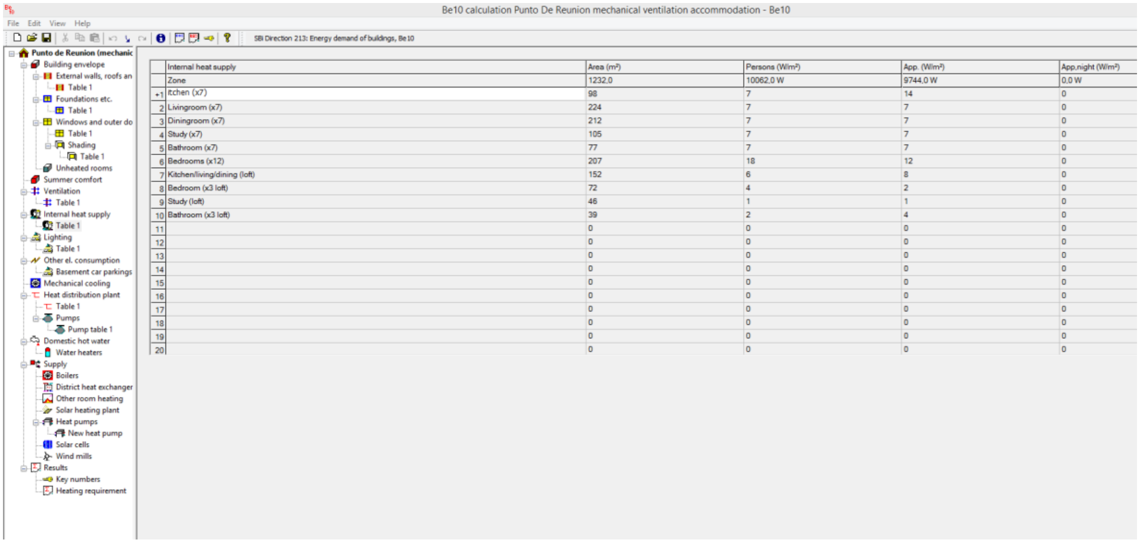


Tabel 26: summer comfort calculation



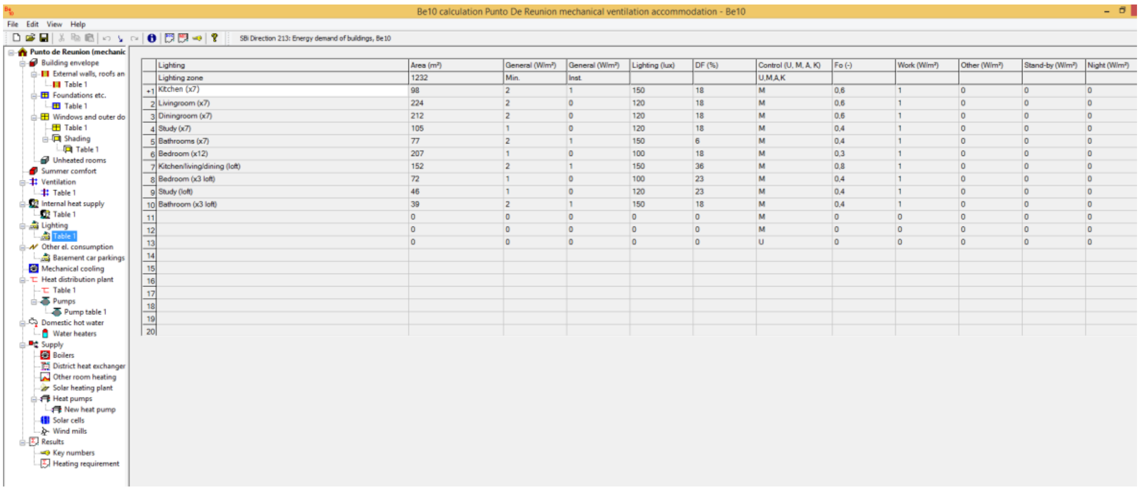
	Ventilation	Area (m²)	Fo, -	qm (l/s m²)	n vgv (-)	ti (°C)	El-HC	qn (l/s m²)	qi,n (l/s m²)	SEL (kJ/m³)	qm,s (l/s m²)	qn,s (l/s m²)	qm,n (l/s m²)	qn,n (l/s m²)
	Zone	1232		Winter			0/1	Winter	Winter		Summer	Summer	Night	Night
1	Kitchen (x7)	98	1	2,7	0,95	18	0	0,3	0,07	1	2,7	1,5	0	1,5
2	Livingroom (x7)	224	1	0,13	0,95	18	0	0,3	0,07	1	0,13	1,5	0	1,5
3	Diningroom (x7)	212	1	0,13	0,95	18	0	0,3	0,07	1	0,13	1,5	0	1,5
4	Study (x7)	105	1	0,13	0,95	18	0	0,3	0,07	1	0,13	1,5	0	1,5
5	Bathroom (x7)	77	1	2,7	0,95	18	0	0,3	0,07	1	2,7	1,5	0	1,5
6	Bedroom (x12)	207	1	0,13	0,95	18	0	0,3	0,07	1	0,13	1,5	0	1,5
7	Living/dining/kithcen (loft)	152	1	2,7	0,95	18	0	0,3	0,07	1	2,7	1,5	0	1,5
8	Study (loft)	72	1	0,13	0,95	18	0	0,3	0,07	1	0,13	1,5	0	1,5
9	Bedroom (x3 loft)	46	1	0,13	0,95	18	0	0,3	0,07	1	0,13	1,5	0	1,5
10	Bathroom (x3 loft)	39	1	2,7	0,95	18	0	0,3	0,07	1	2,7	1,5	0	1,5
11		0	0	0	0	0	0	0	0	0	0	0	0	0
12		0	0	0	0	0	0	0	0	0	0	0	0	0
13		0	0	0	0	0	0	0	0	0	0	0	0	0
14		0	0	0	0	0	0	0	0	0	0	0	0	0
15		0	0	0	0	0	0	0	0	0	0	0	0	0
16		0	0	0	0	0	0	0	0	0	0	0	0	0
17		0	0	0	0	0	0	0	0	0	0	0	0	0
18		0	0	0	0	0	0	0	0	0	0	0	0	0
19		0	0	0	0	0	0	0	0	0	0	0	0	0
20		0	0	0	0	0	0	0	0	0	0	0	0	0

Tabel 25: ventilation calculation



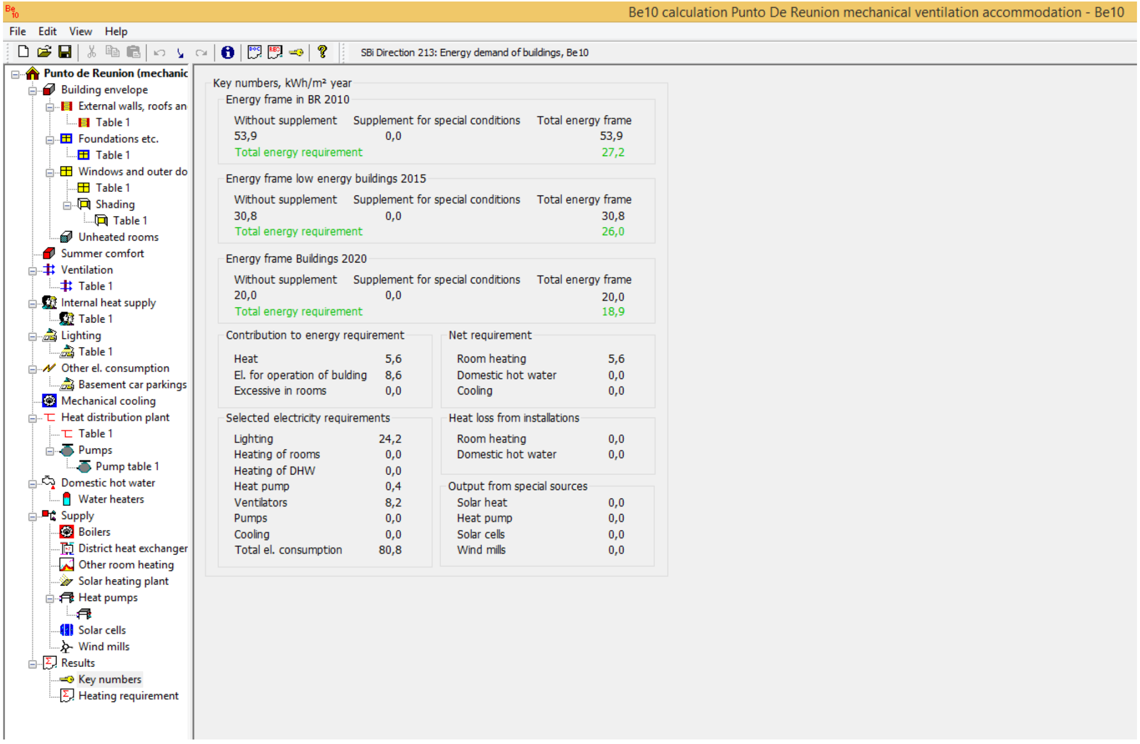
	Internal heat supply	Area (m²)	Persons (W/m²)	App. (W/m²)	App.night (W/m²)
	Zone	1232,0	10062,0 W	9744,0 W	0,0 W
+1	itchen (x7)	98	7	14	0
2	Livingroom (x7)	224	7	7	0
3	Diningroom (x7)	212	7	7	0
4	Study (x7)	105	7	7	0
5	Bathroom (x7)	77	7	7	0
6	Bedrooms (x12)	207	18	12	0
7	Kitchen/living/dining (loft)	152	6	8	0
8	Bedroom (x3 loft)	72	4	2	0
9	Study (loft)	46	1	1	0
10	Bathroom (x3 loft)	39	2	4	0
11		0	0	0	0
12		0	0	0	0
13		0	0	0	0
14		0	0	0	0
15		0	0	0	0
16		0	0	0	0
17		0	0	0	0
18		0	0	0	0
19		0	0	0	0
20		0	0	0	0

Tabel 28:overview internal heat supply

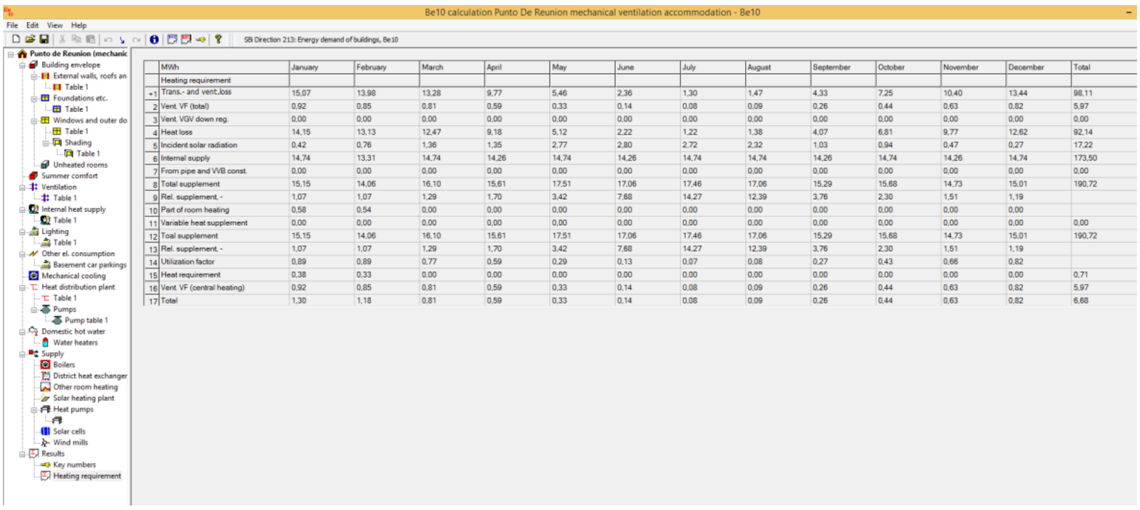


	Lighting	Area (m²)	General (W/m²)	General (W/m²)	Lighting (lux)	DF (%)	Control (U, M, A, K)	Fo (-)	Work (W/m²)	Other (W/m²)	Stand-by (W/m²)	Night (W/m²)
	Lighting zone	1232	Min.	Inst.			U,M,A,K					
+1	Kitchen (x7)	98	2	1	150	18	M	0,6	1	0	0	0
2	Livingroom (x7)	224	2	0	120	18	M	0,6	1	0	0	0
3	Diningroom (x7)	212	2	0	120	18	M	0,6	1	0	0	0
4	Study (x7)	105	1	0	120	18	M	0,4	1	0	0	0
5	Bathrooms (x7)	77	2	1	150	6	M	0,4	1	0	0	0
6	Bedroom (x12)	207	1	0	100	18	M	0,3	1	0	0	0
7	Kitchen/living/dining (loft)	152	2	1	150	36	M	0,8	1	0	0	0
8	Bedroom (x3 loft)	72	1	0	100	23	M	0,4	1	0	0	0
9	Study (loft)	46	1	0	120	23	M	0,4	1	0	0	0
10	Bathroom (x3 loft)	39	2	1	150	18	M	0,4	1	0	0	0
11		0	0	0	0	0	M	0	0	0	0	0
12		0	0	0	0	0	M	0	0	0	0	0
13		0	0	0	0	0	U	0	0	0	0	0
14												
15												
16												
17												
18												
19												
20												

Tabel 27: Overview lighting



Tabel 29: Overview energy requirements/ key numbers



	MWh	January	February	March	April	May	June	July	August	September	October	November	December	Total
	Heating requirement													
+1	Trans.- and vent.loss	15,07	13,98	13,28	9,77	5,46	2,36	1,30	1,47	4,33	7,25	10,40	13,44	98,11
2	Vent. VF (total)	0,92	0,85	0,81	0,59	0,33	0,14	0,08	0,09	0,26	0,44	0,63	0,82	5,97
3	Vent. VGV down reg.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4	Heat loss	14,15	13,13	12,47	9,18	5,12	2,22	1,22	1,38	4,07	6,81	9,77	12,62	92,14
5	Incident solar radiation	0,42	0,76	1,36	1,35	2,77	2,80	2,72	2,32	1,03	0,94	0,47	0,27	17,22
6	Internal supply	14,74	13,31	14,74	14,26	14,74	14,26	14,74	14,74	14,26	14,74	14,26	14,74	173,50
7	From pipe and VVB const.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
8	Total supplement	15,15	14,06	16,10	15,61	17,51	17,06	17,46	17,06	15,29	15,68	14,73	15,01	190,72
9	Rel. supplement, -	1,07	1,07	1,29	1,70	3,42	7,68	14,27	12,39	3,76	2,30	1,51	1,19	
10	Part of room heating	0,58	0,54	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
11	Variable heat supplement	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
12	Toal supplement	15,15	14,06	16,10	15,61	17,51	17,06	17,46	17,06	15,29	15,68	14,73	15,01	190,72
13	Rel. supplement, -	1,07	1,07	1,29	1,70	3,42	7,68	14,27	12,39	3,76	2,30	1,51	1,19	
14	Utilization factor	0,89	0,89	0,77	0,59	0,29	0,13	0,07	0,08	0,27	0,43	0,66	0,82	
15	Heat requirement	0,38	0,33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,71
16	Vent. VF (central heating)	0,92	0,85	0,81	0,59	0,33	0,14	0,08	0,09	0,26	0,44	0,63	0,82	5,97
17	Total	1,30	1,18	0,81	0,59	0,33	0,14	0,08	0,09	0,26	0,44	0,63	0,82	6,68

Tabel 30: Overview heating requirements.