Passivhaus project documentation

Project Documentation
파시브하우스 건축 프로젝트 보고서

Certified Passivhaus
Passivhaus Institut
| classic | plus | premium |

1. Abstract / 요약

Single family detached house in Pangyo, Seongnam-si, KOREA

1.1. Data of building / 건물 정보

Year of construction/ 완공년도	2015	**Space heating / 난방에너지요구량**	**13 kWh/(m²a)**
U-value external wall/ 외벽의 열관류율	0.090 W/(m²K)		
U-value floor slab/ 바닥의 열관류율	0.130 W/(m²K)	**Primary Energy Renewable (PER) / 재생가능 1차에너지 요구량 (PER)**	63 kWh/(m²a)
U-value roof/ 지붕의 열관류율	0.073 W/(m²K)	**Generation of renewable energy / 재생가능에너지 발전량**	44 kWh/(m²a)
U-value window/ 창문의 열관류율	0.87 W/(m²K)	**Non-renewable Primary Energy (PE) / 화석연료 1차에너지 요구량 (PE)**	69 kWh/(m²a)
Heat recovery/ 환기장치의 열회수율	81.2%	Pressure test n_{50} / 기밀 성능 n_{50}	0.34 h^{-1}
Special features/ 특이 사항			

1.2. Brief Description

Pangyo Passivhaus

Pangyo Passivhaus is a detached 225.6 m², 2 story dwelling in Pangyo new town district, Seongnam city. It is completed in 2015, and Byoung-Eun Jeong (Byung Un Jung), the architect and the constructor of this house has been lived in it since its completion.

It has a steel structure with H-Beam and plywood envelopes. There are 4 bedrooms, 1 living room, 1 dining-kitchen, 5 bathrooms and an attic. On the ground floor, there are 3 independent rooms with their own bathroom, so it can be possible to rent those rooms or to give those to grown-up sons and daughters. On the first floor, there are one main bedroom and a living room, dining-kitchen etc for family's daily life.

On the roof, there is 5.75 kWp PV system. It can produce about 6,000 kWh of renewable electricity annually.

1.2. 간단한 소개

판교 파시브하우스

판교 파시브하우는 성남시 판교 신도시에 위치한 순수바닥면적 225.6 m², 2층 규모의 단독주택입니다. 2015년에 완공되어 설계자이자 시공자인 이에코 건설 정병은 사장이 거주하고 있습니다.

철골 구조에 판재로 외피를 형성한 건물로서 4개의 침실과 1개의 거실, 1개의 식당 겸 부엌, 5개의 화장실 그리고 다락을 가진 집입니다. 1층에는 각기 화장실 겸 샤워실이 붙은 독립된 방 3개가 있어서 성인 자녀가 독립생활을 하거나 세를 줄 수도 있습니다. 2층에는 부부 침실과 거실, 식당과 부엌 등이 있어 가족의 주생활공간이 됩니다.

지붕에는 5.75 kWp 규모의 태양광 발전설비가 있어 연간 약 6,000 kWh 내외의 재생가능전기를 생산할 수 있습니다.

1.3. Responsible project participants / 건축 프로젝트 참여자

Architect/ 설계자	Byoung-Eun Jeong (Byung Un Jung : former) - E-Eco Construction 정병은 – 이에코 건설
Implementation planning/ 실시설계	Byoung-Eun Jeong (Byung Un Jung : former) - E-Eco Construction 정병은 – 이에코 건설
Building systems/ 건축설비	Pil-Ryul Lee 이필렬
Structural engineering/ Baustatik	
Building physics/ 건축물리	Pil-Ryul Lee 이필렬
Passive House project planning/ 파시브하우스 계획	Wooseok Choe – PassivTech Lab 최우석 – 파시브기술연구소
Construction management/ 시공	Byoung-Eun Jeong (Byung Un Jung : former) - E-Eco Construction 정병은 – 이에코 건설

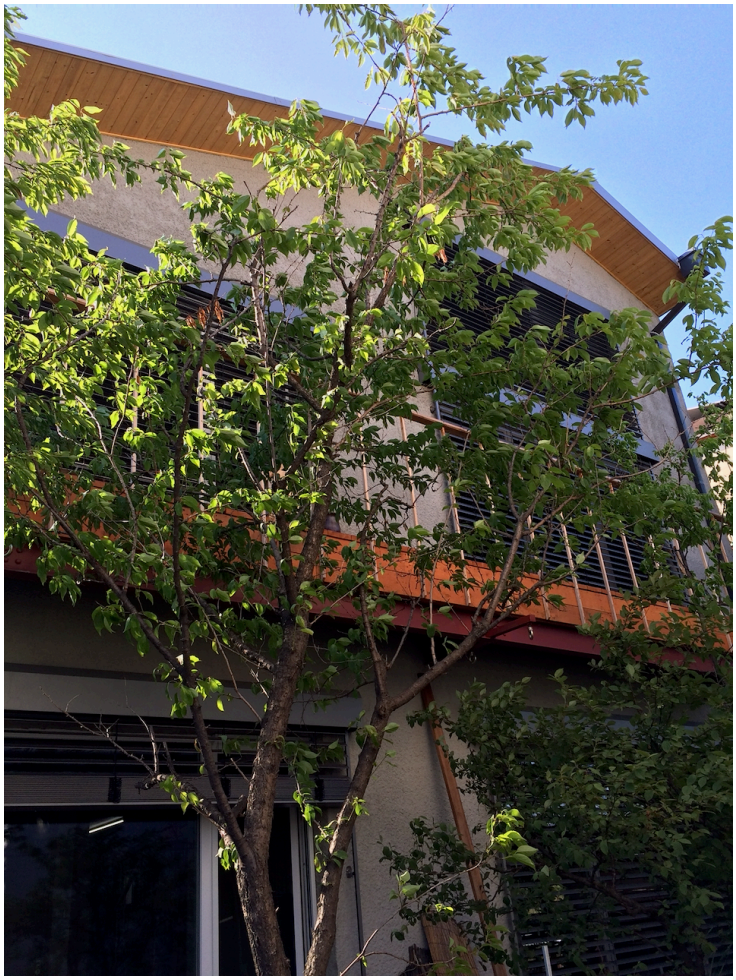
Certifying body/ Zertifizierungsstelle	Peter Andreas-Tschiesche, Energie- und Umweltzentrum Allgäu www.eza-allgaeu.de
Certification ID/ Zertifizierungs ID	25100_EZA_PH_20191206_PAT ID: 6487 (www.passivehouse-database .org)

Author of project documentation / 프로젝트 보고서 작성자	Wooseok Choe – PassivTech Lab 최우석 – 파시브기술연구소
Date, Signature/ 날짜, 서명	16 Feburary 2021

2. Views of the Building

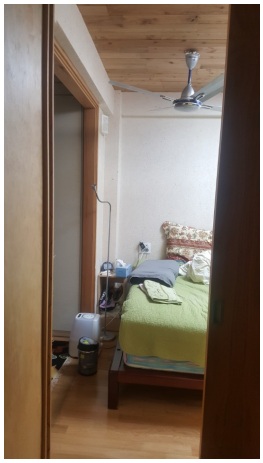
Front entrance elevation. This west-north side borders the road and has very small windows.

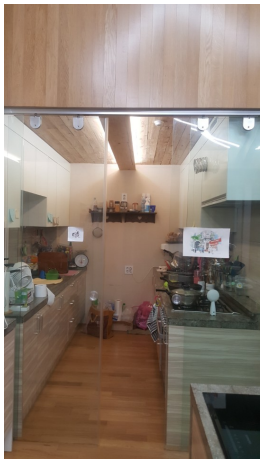
South-west side faces the neighbour house. It has big windows and external venetian blinds. There can be seen the outdoor air intake hood, the exhaust air outlet hood on the ground floor, and the flue terminal for the gas boiler on the first floor.



East-south side faces the private garden. It also has big windows and external venetian blinds. There is also a balcony which is made of steel H-beam structure. But the measures for thermal bridge reduction had been applied.

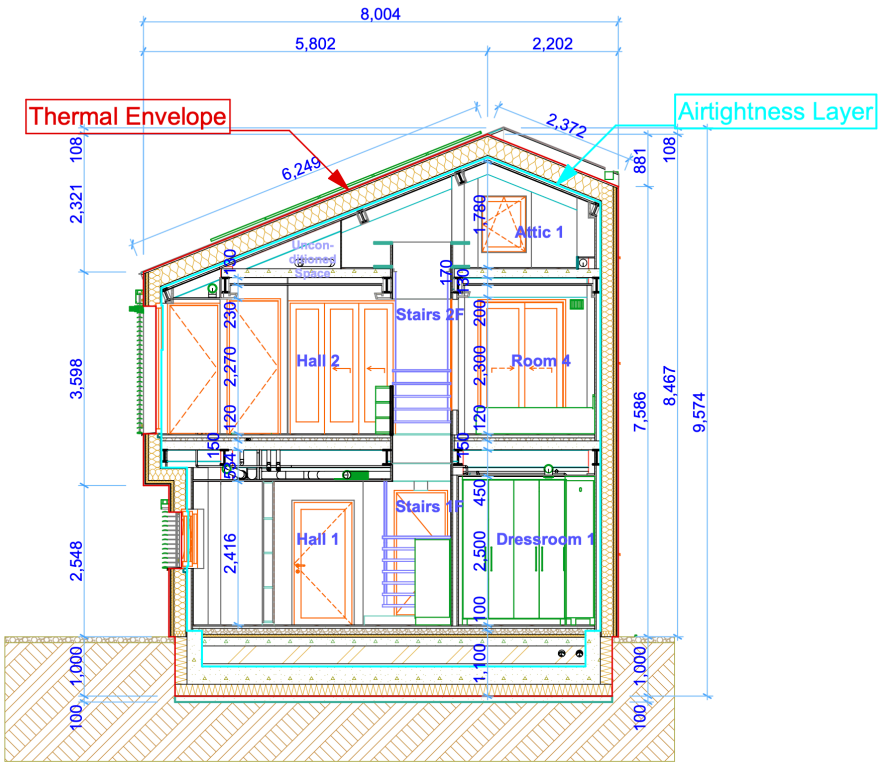
Interior views. From upper left picture, Living Room Low & Attic 2, Living Room High, Room 4, Kitchen, Room 3 & Hall 1, Room 1.





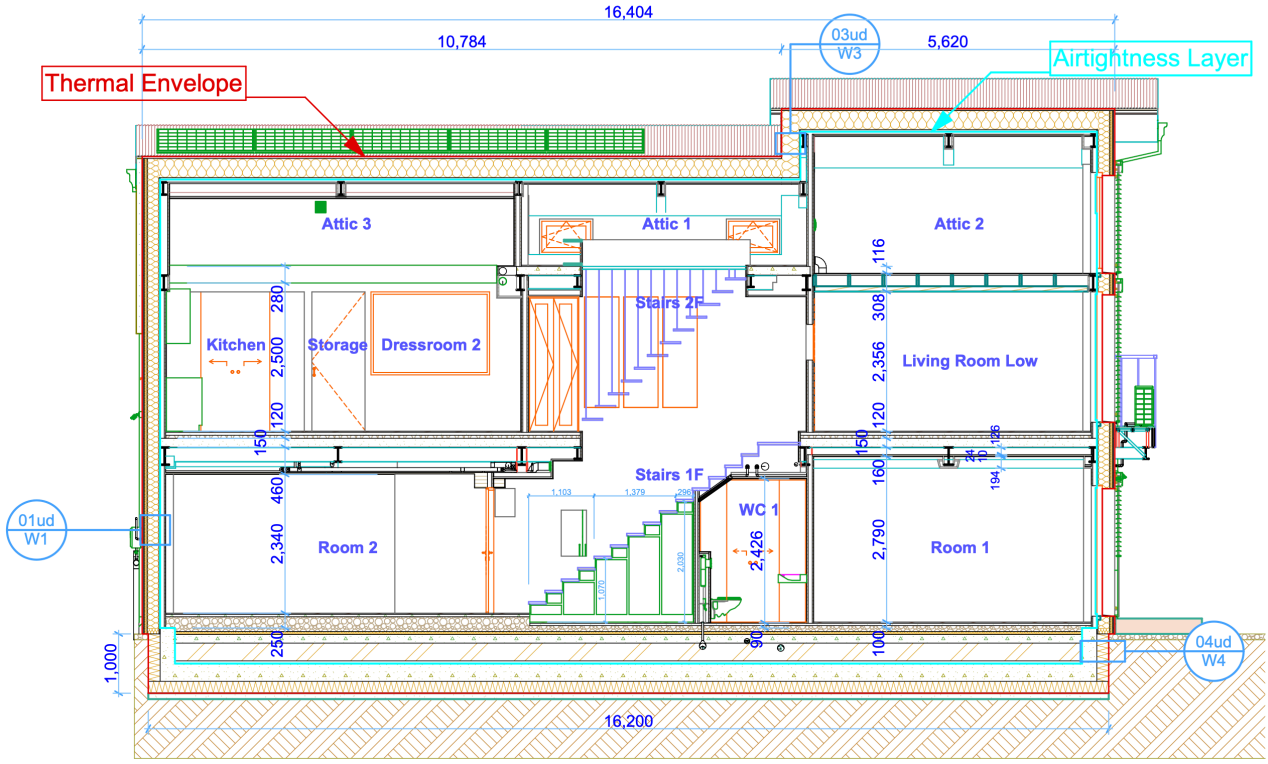
3. Sectional drawing

3.1. Typical cross-section

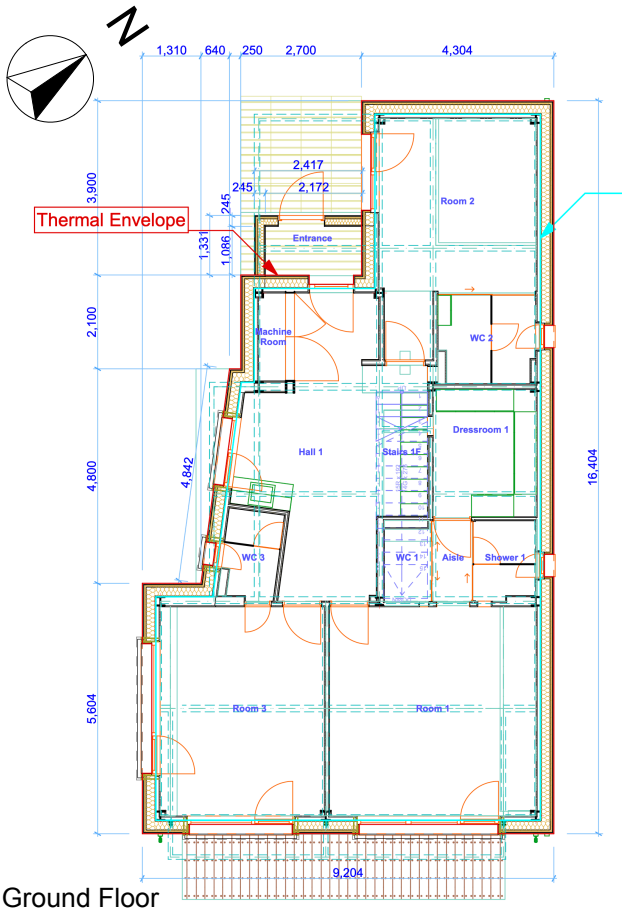


Pangyo Passivhaus has one uninterrupted thermal envelope and one continuous airtightness layer. In the sectional drawing, those can be seen. Those also can be recognizable on the floor plan drawing in the next section.

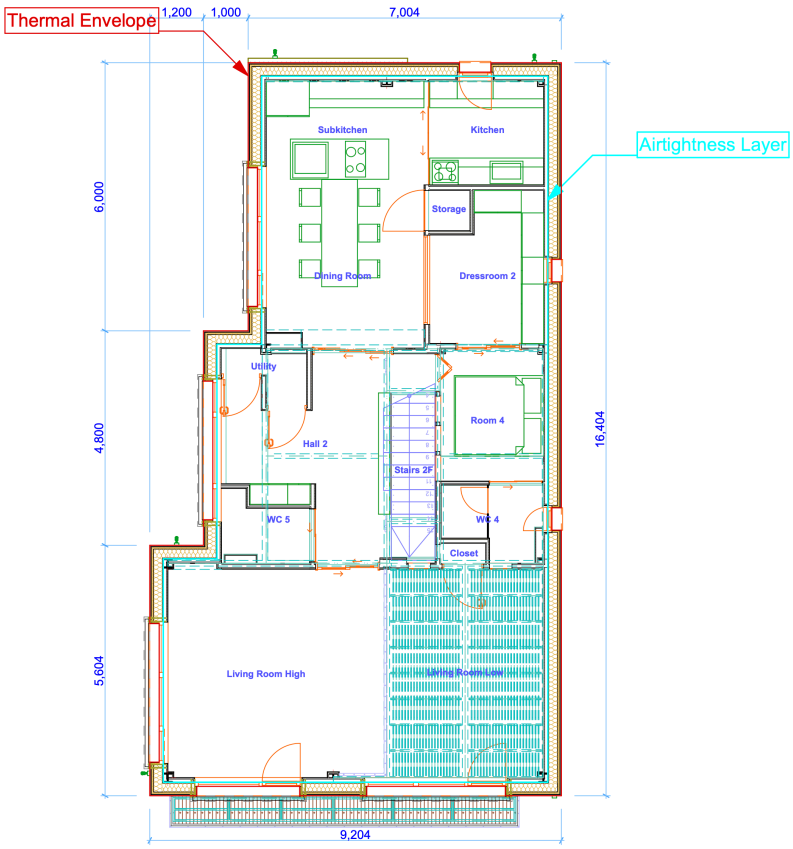
3.2. Typical logitudinal section



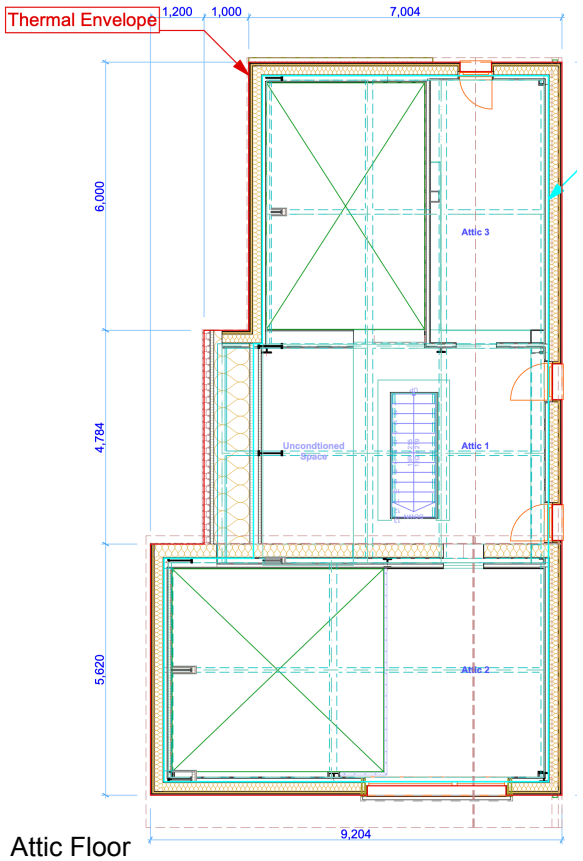
4. Floor plans



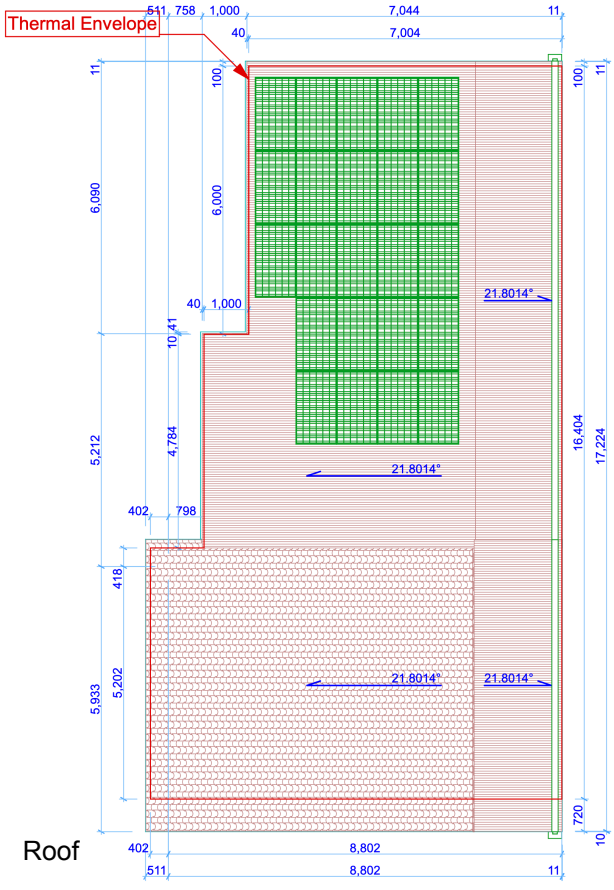
Ground Floor



1st Floor



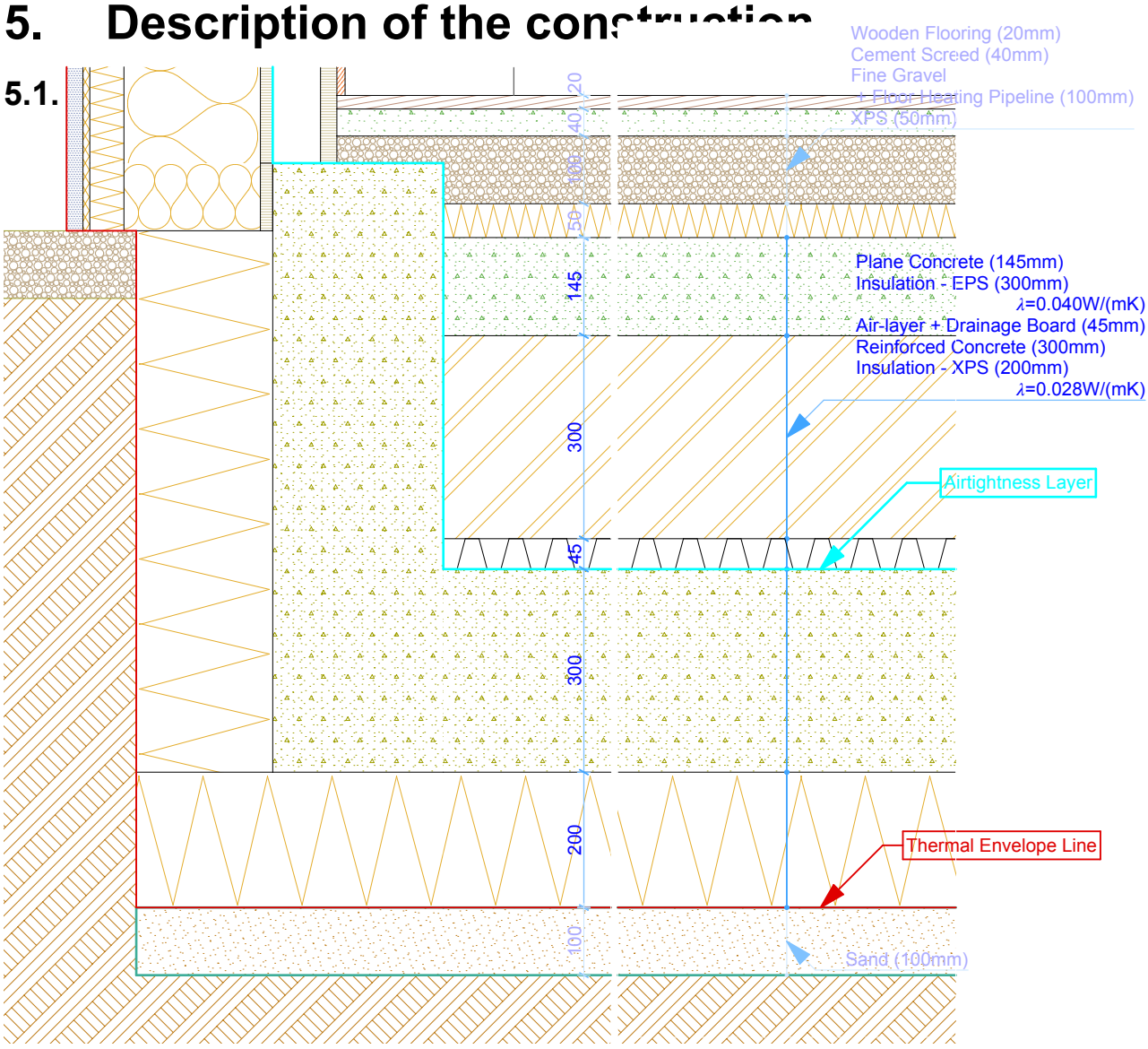
Attic Floor



Roof

5. Description of the construction

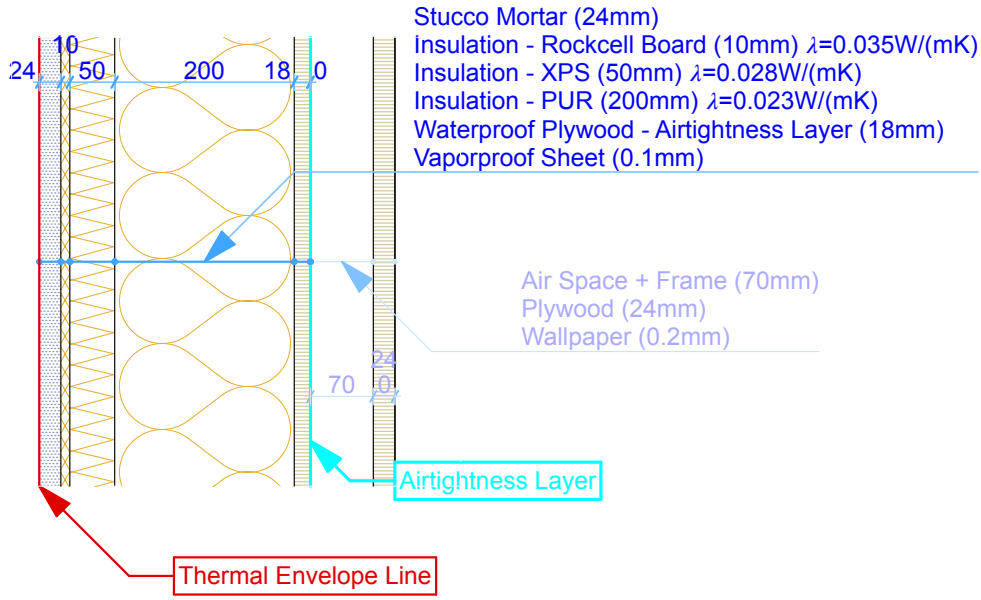
5.1.



Ground floor slab build-up:

Ground Floor Slab	300mm Reinforce Concrete 200mm Insulation - XPS (λ=0.028 W/(mK)) 100mm Sand	U-Value 0.134 W/(m²K)

5.2. Exterior Wall

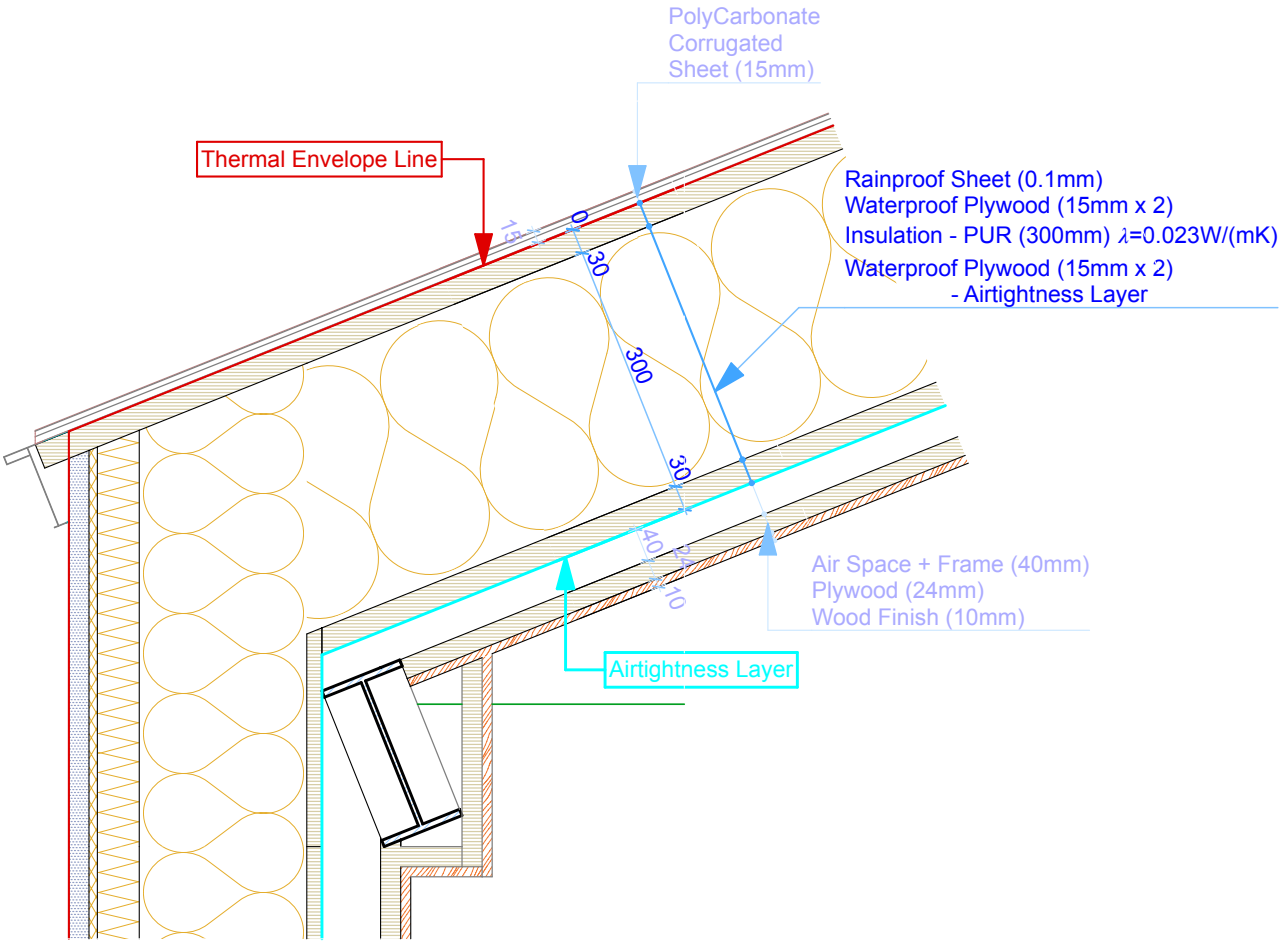


Pangyo Passivhaus has two layers of insulation, 200mm PUR insulation board and 60mm composite board made up of 10mm calcium carbonate insulation(Rockcell Board) and 50mm XPS. The Rockcell Board, calcium carbonate insulation board is good for stucco mortar plaster finishing and it is fire-resistant, waterproof.

Exterior wall build-up:

Exterior Wall	24mm Stucco mortar exterior plaster 10mm Insulation - Rockcell board (λ=0.035 W/(mK)) 50mm Insulation - XPS (λ=0.028 W/(mK)) 200mm Insulation - PUR (λ=0.023 W/(mK)) 18mm Waterproof plywood Vaporproof Sheet	U-Value 0.09 W/(m²K)

5.3. Roof

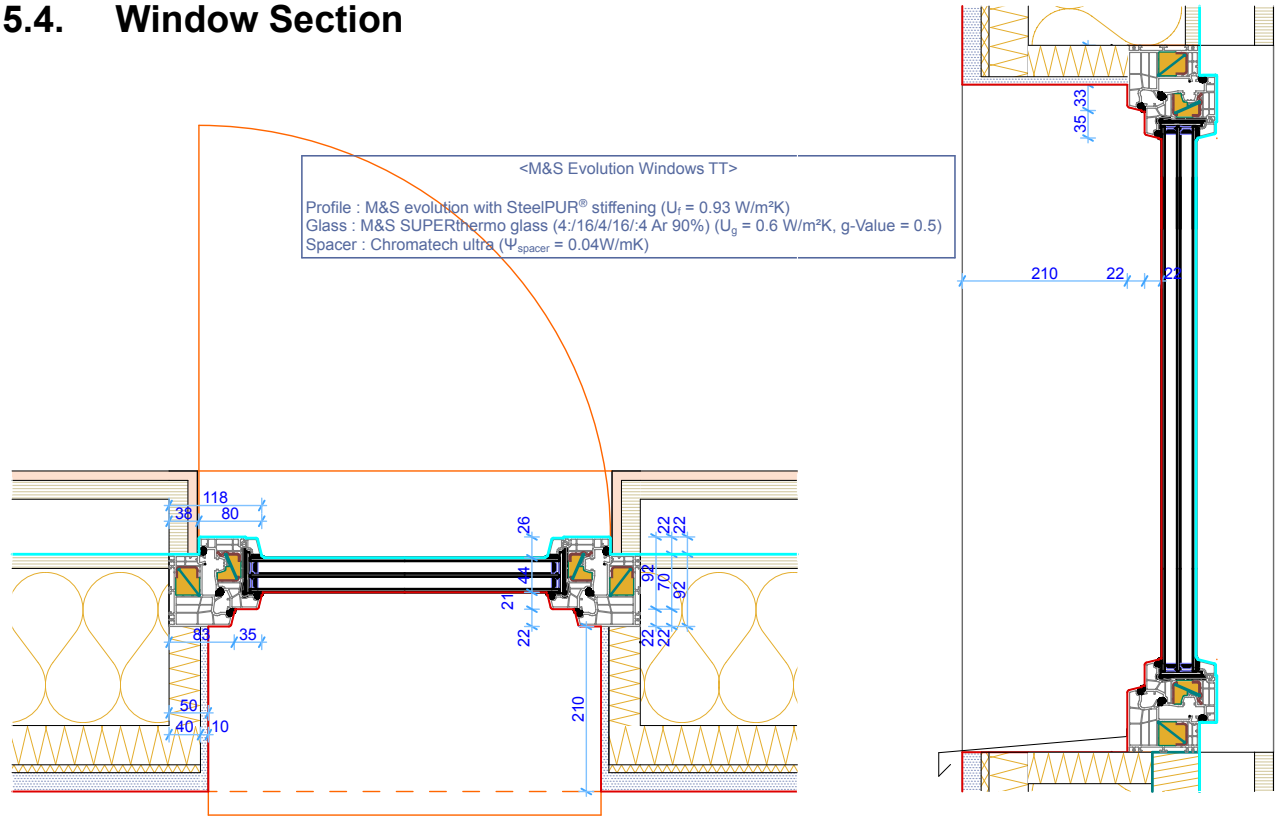


The gabled roof has more thickened insulation layer than wall and slab. For the finishing 2 layers of waterproof plywood are glued on the insulation layer and it is covered with polycarbonate corrugated sheets, relatively cheap and practical material. Roof covers are fixed with screws on the plywood.

Roof build-up:

Roof	Polycarbornate corrugated sheet Rainproof Sheet 30mm Waterproof Plywood 300mm Insulation - PUR (λ=0.023 W/(mK)) 30mm Waterproof plywood	U-Value 0.073 W/(m²K)

5.4. Window Section



2 sides low-E coated(2nd, 5th side) three panes glazing filled with argon gas was used. PVC window frames (salamander bluEvolution 92) have 6 chambers with steelPUR stiffening for thermal insulating effect. Warm edge spacers are used to triple-pane glass for low thermal transmittance. For better thermal performance window frames are partly covered with insulation.

Window build-up:

Glass	4:/16/4/16/:4 triple pane low-e glass Ar 90%	g-Value 0.5	U_g-Value 0.60 W/(m²K)
Frame	PVC Window Frame		U_f-Value 0.93 W/(m²K)
Spacer	Chromatech ultra spacer		$\Psi_{glazing\ edge}$ 0.04 W/(mK)

6. Airtight envelope

6.1. Airtight layer

18mm waterproof plywoods make the airtight layer of the wall and roof. In the floor slab, the concrete foundation itself make the airtight layer. On the joint between the plywoods, plywoods and the concrete foundation, plywoods and the window frames, plywoods and the wall-penetrating things, the airtightness tape (ISOVER Vario multitape, SIGA Wigluv) is applied.

6.2. Blower door test

Measurement of air permeability
according to EN 13829 (2001)

Page 1/5: Certificate

Passivhaus Design
Wooseok Choe
Naruteo-gil 45
12563 Yangpyeong-gun
+82-10-6763-9007

WÖHLER

Certificate

on the air permeability of the building

The building / object:

Pangyo PH
482-3, Pangyo-dong
13473 Seongnam-si

tested on:

2015-07-01

achieved the following value for the volume-related leakage flow:

n50 = 0.34 1/h

(equivalent to a pressure difference between inside and outside of 50 Pa measured volumetric air flow - relative to the heated volume, EnEV Appendix 4, section 2)

By the Energy Saving Ordinance (EnEV) permissible limit value is:

in buildings without air conditioning systems: 3 1 / h and
in buildings with ventilation systems: 1.5 1 / h.

The limit of the EnEV is not exceeded.

Please note: The test result doesn't preclude (hidden) lacks in building cunstruction.

Place, Date	Examiner, Company	Signature
Yangpyeong, 2015-07-01	Wooseok Choe Passivhaus Design	

Measurement of air permeability
according to EN 13829 (2001)

Page 4/5: Measurement result Woehler BC 21

Passivhaus Design
Wooseok Choe
Naruteo-gil 45
12563 Yangpyeong-gun
+82-10-6763-9007

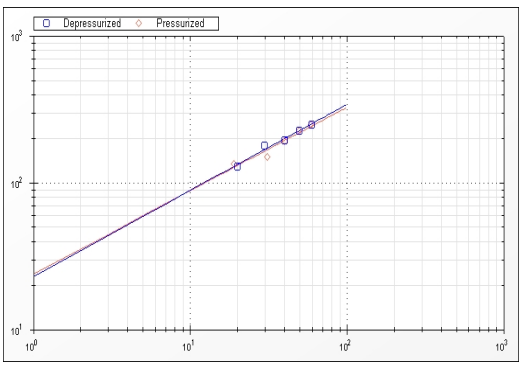
Measurement data											
Depressurized	20	30	40	50	60	0	0	0	0	0	Pa
Air flow	128	178	194	226	249	0	0	0	0	0	m³/h
Pressurized	19	31	40	50	59	0	0	0	0	0	Pa
Air flow	135	151	191	227	249	0	0	0	0	0	m³/h

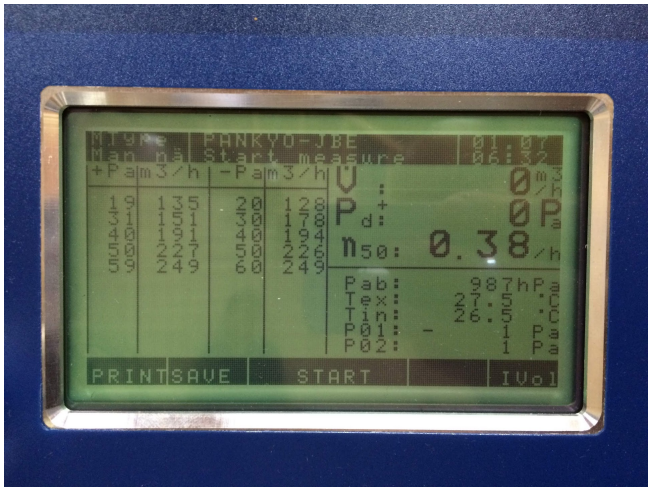
Natural pressure differences		
before		
dP0,1 +	0	Pa
dP0,1 -	0	Pa
dP0,1	-1	Pa
after		
dP0,2 +	0	Pa
dP0,2 -	0	Pa
dP0,2	1	Pa

Results	Depress.	Pressurized
Air flow coefficient - Cenv [m³/h]:	22.88	23.78
Confidence Interval (95%)	13.09 39.98	8.98 62.98
Air flow exponent - n	0.59	0.57
Confidence Interval (95%)	0.43 0.74	0.30 0.84
Air leakage coefficient - CL [m³/h]	22.37	23.27
Confidence Interval (95%)	12.80 39.10	8.78 61.63
Leakage Air flow - V50 [m³/h]	222	215
Confidence Interval (95%)	206 239	188 245

Environmental Data		
Barometric press.	987	hPa
T - Outside	27.5	°C
T - Inside	26.5	°C

Characteristics		Depress	Press.	**Avg.**	
Air change rate	**n50**	0.35	0.34	**0.34**	1/h
Specific leakage rate	w50	0.98	0.95	**0.97**	m³/h/m²
Air permeability	q50	0.31	0.30	**0.31**	m³/h/m²





Passivhaus Design
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WÖHLER

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on the air permeability of the building

The building / object:

Pangyo PH
482-3, Pangyo-dong
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tested on:

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Please note: The test result doesn't preclude (hidden) lacks in building cunstruction.

Place, Date	Examiner, Company	Signature
Yangpyeong, 2015-07-01	Wooseok Choe Passivhaus Design	

Measurement of air permeability
according to EN 13829 (2001)

Page 2/5: Building description

Passivhaus Design
Wooseok Choe
Naruteo-gil 45
12563 Yangpyeong-gun
+82-10-6763-9007

Applicant	
Customer number	11
Customer name	Jeong, Byoung-Eun
Address	49-1, Pangyo-ro 209beon-gil
ZIP, City	13473 Seongnam-si

Application	
DIN EN 13829 (A)	☑
DIN EN 13829 (B)	■
EnEV/DIBt	■
Leakage detection	■
Check-up of improvements	■

Type of leakage detection / Visualization with ...	
BC 21	☑
Photo	■
Thermal Image	■
Thermo Anemometer	■
Smoke Puffer	■

Project	
Project Nr.	20150701-1 BlowerDoor Test for Pangyo PH
Name	Pangyo PH
Address	482-3, Pangyo-dong
ZIP, City	13473 Seongnam-si

Project data	
Building constr. finished	☑
Airtight layer finished	☑
Wind exposure (ABC)	B (partially exposed building)
Wind force [Beaufort]	3 (Gentle breeze (3,6-5,4 m/s))
HVAC system (Yes/No)	YES
HVAC system	Paul Novus 300
Test standard	EN 13829 (A)
Building construction year	2015
Building height [m]	9.46
Place / Room	Hall 1
Location of installation	Sw-2
Install. height o. ground [m]	1.15
Net volume [m³]	641
Net floor area [m²]	226
Envelope area [m²]	706
Comment BC 21	
Test date	2015-07-01

Page 3/5: Preliminary Check

Passivhaus Design
Wooseok Choe
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Preliminary Check

- ☑ Exterior doors and windows closed (A + B)
- ■ Doors to unheated basements or rooms closed (A + B)
- ■ Hatches, attic stairs closed (A + B)
- ☑ Interior doors opened in the heated rooms (A + B)
- ☑ Sewers sealed, siphon filled with water (A + B)
- ■ The sewer pipe aerator removed and sealed (A + B)
- ■ Ashes removed from open fireplaces (A + B)
- ☑ Mechanical ventilation and air conditioning switched off (A + B)
- ■ Supply and exhaust diffusers sealed (A + B)
- ■ Ventilation tubes sealed at the fan (A + B)
- ■ Open fireplace: chimney damper closed. and ash removed (A + B)
- ■ Closed fireplace: inlet air closed (A + B)
- ☑ Exhaust outlets closed (A)
- ☑ Supply and exhaust diffusers closed (A)
- ■ Exhaust diffusers sealed (B)
- ■ Kitchen hood seal (B)
- ■ Letterbox sealed (B)
- ■ Sealed chimney ventilation (B)

Deviations to EN 13829

Additional temporary seals

Measurement of air permeability

according to EN 13829 (2001)

Page 4/5: Measurement result Woehler BC 21

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dP0,1 +	0	Pa
dP0,1 -	0	Pa
dP0,1	-1	Pa
after		
dP0,2 +	0	Pa
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dP0,2	1	Pa

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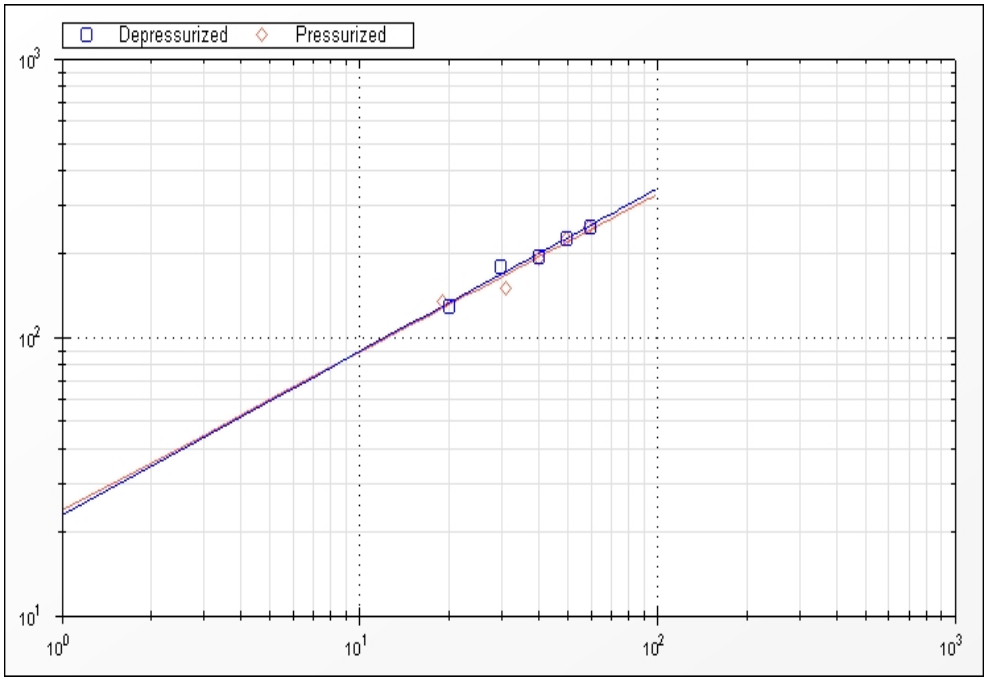
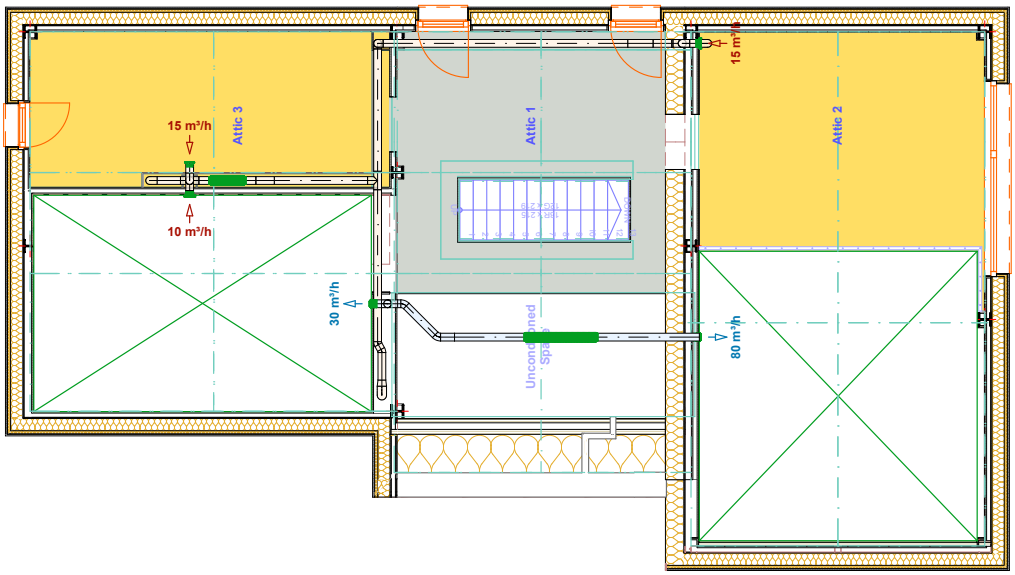


7. Ventilation system

7.1. Ventilation ductwork



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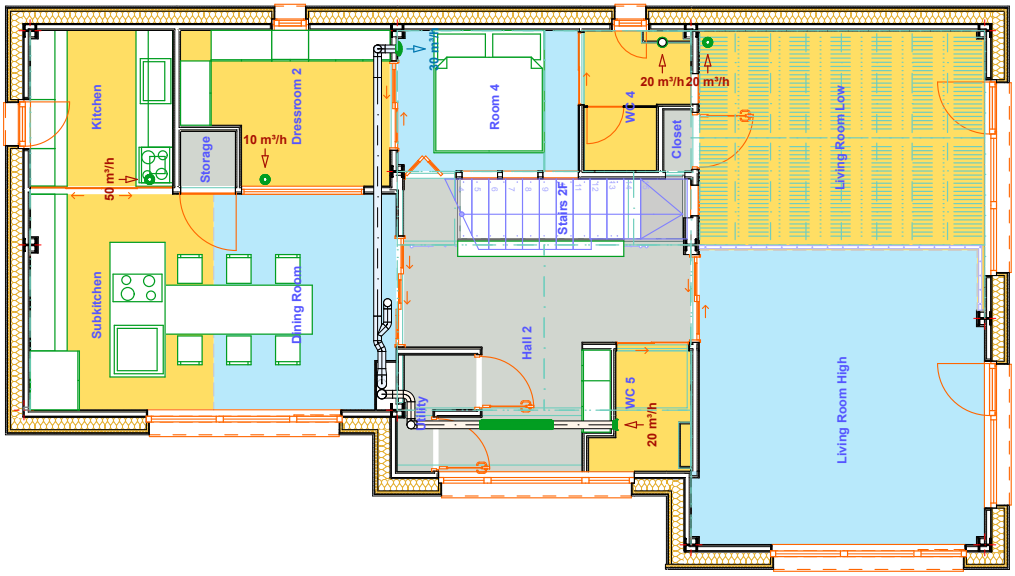
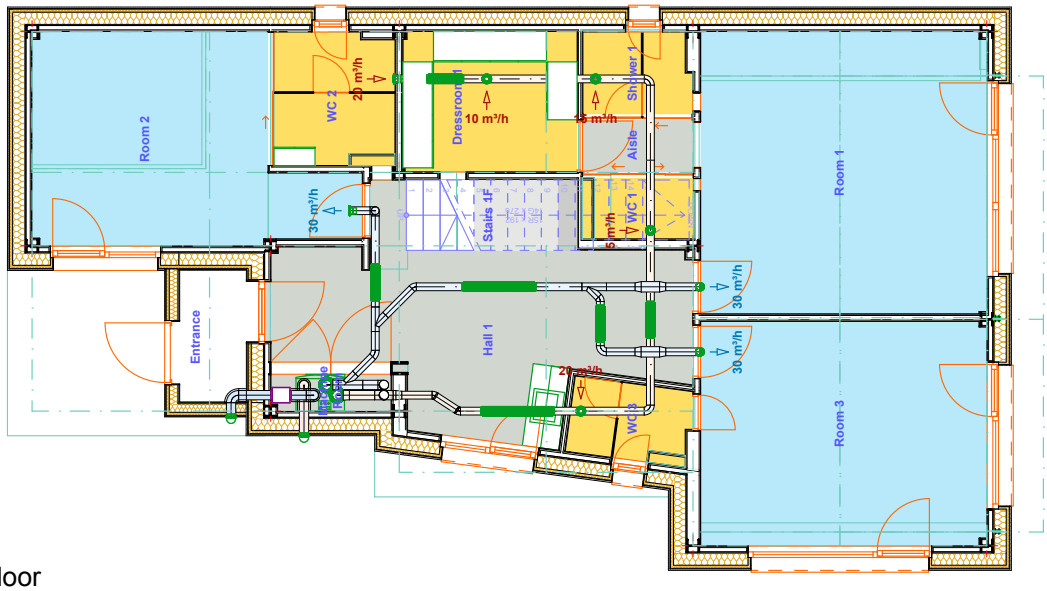
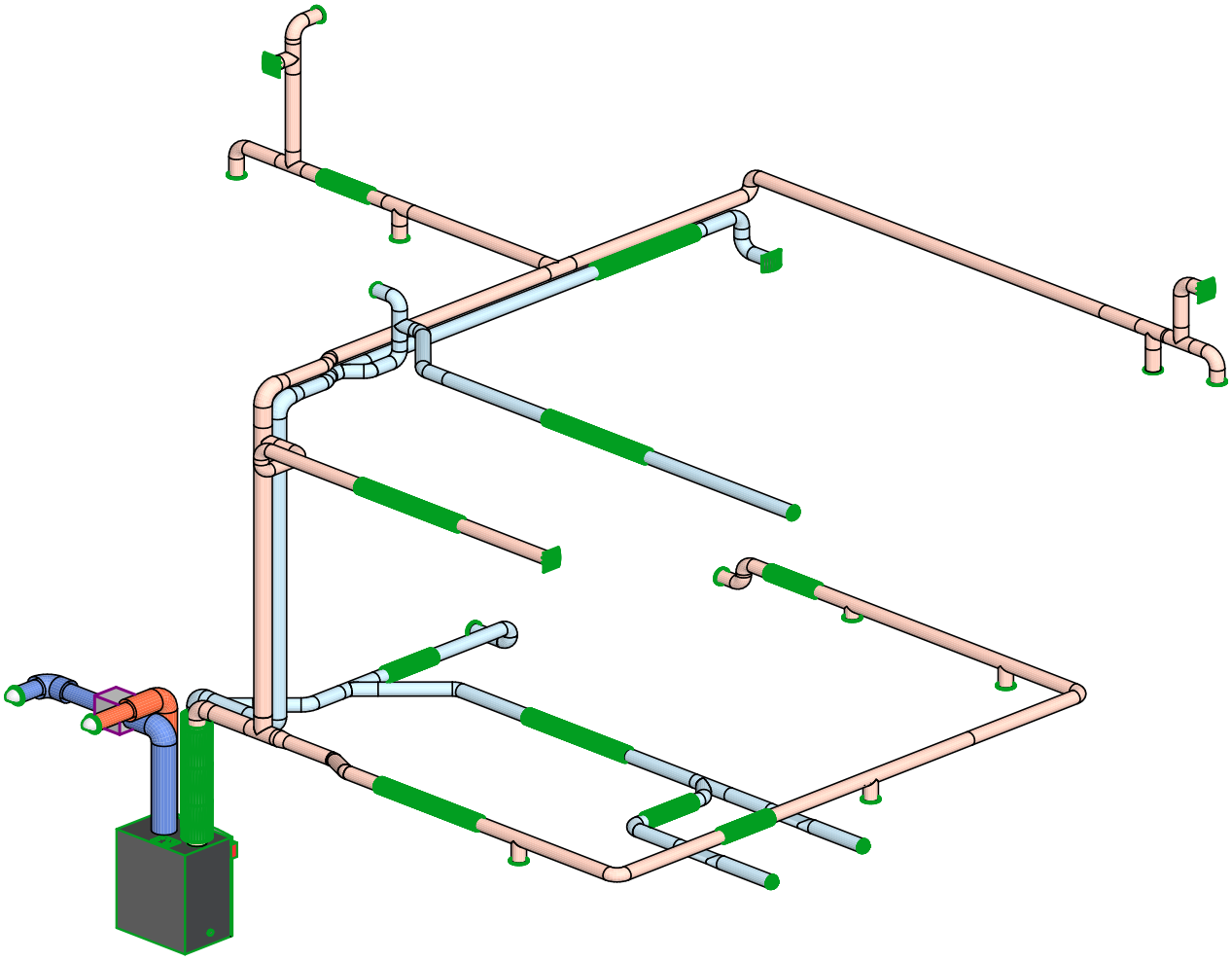


1st floor



Ground floor

The ventilation ductwork had been planned and implemented following rules of cross ventilation. There are supply air zones (blue coloured), extract air zones (yellow coloured), and transfer air zones (grey coloured). Fresh air is supplied to the living spaces like Room 1~4, living room, dining room through supply air ducts (blue ducts). Indoor air is extracted at the wet or dust-rich spaces like WC 1~5, Shower 1, Dressroom 1~2, Kitchen and Subkitchen, the lower part of the living room through extract air ducts (pink ducts). Air transfer takes place mainly through the door gap between the bottom of the doors and floor (20~30mm).



3. Distribution of the airflow volume flow rate

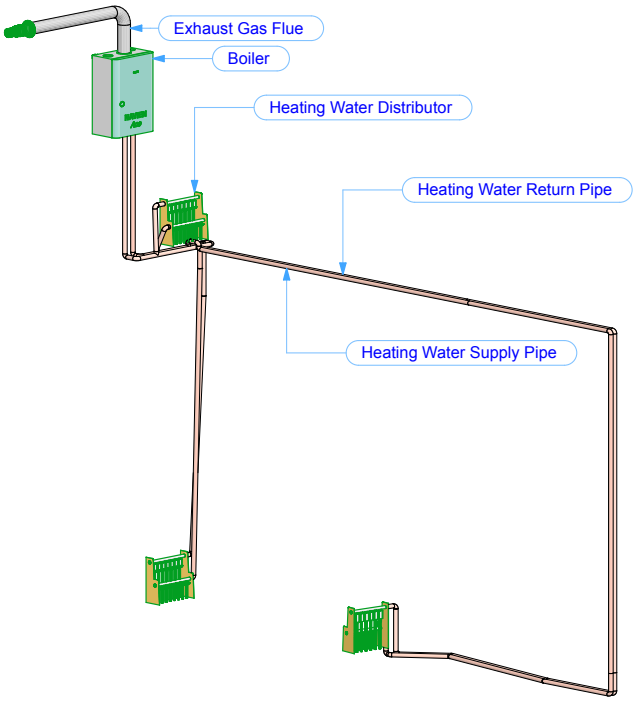
Nr.	Room	Area	Clear Height	Room Volume	Air Volume Flow Rate			Air Change Rate	Type of Flow-Off Vent
	(each valve individually)	A	h	A x h	V_{SU}	V_{EX}	$V_{THROUGH}$	n	(door gap, grid in door leaf
		m²	m	m³	m³/h	m³/h	m³/h	1/h	door frame, valve ...)
1	101-1 Room 1	21.60	2.72	58.8	30			0.51	door gap
2	101-3 WC 1	1.81	2.37	4.3		5		1.17	door gap
3	101-4 Shower 1	2.31	2.43	5.6		15		2.67	door gap
4	101-5 Dressroom 1	6.54	2.50	16.4		10		0.61	door gap
5	102-1 Room 2	15.19	2.45	37.2	30			0.81	door gap
6	102-2 WC 2	4.23	2.35	9.9		20		2.01	door gap
7	103-1 Room 3	17.17	2.74	47.1	30			0.64	door gap
8	103-2 WC 3	2.41	2.43	5.8		20		3.42	door gap
9	201-1 Living Room Hi	22.36	3.70	82.8	80			0.97	open space, door gap
10	201-2 Living Room Lo	16.78	2.63	44.1		20		0.45	open space
11	202-1 Room 4	6.76	2.43	16.4	30			1.83	door gap
12	202-2 WC 4	3.34	2.51	8.4		20		2.39	door gap
13	202-3 Dressroom 2	7.71	2.40	18.5		10		0.54	door gap
14	203-2 WC 5	2.78	2.50	6.9		20		2.88	door gap
15	204-1 Dining Room	10.22	3.29	33.6	30			0.89	open space, door gap
16	204-2 Subkitchen	10.51	3.37	35.4		10		0.28	open space
17	204-4 Kitchen	5.90	2.40	14.2		50		3.53	door gap
18	301-2 Attic 2	16.78	2.36	39.6		15		0.38	open space
19	301-3 Attic 3	14.97	1.56	23.3		15		0.64	open space
20	Other TRAs	60.78	2.17	132.1			65	0.49	open space
	sum:	250.15	---	640.53	230.0	230.0	---	0.36	

7.2. Ventilation system

Paul Novus F 300 (PHI Certified Unit) had been installed for energy recovery ventilation. It is fitted with supply F7 filter, extract G4 filter, and those are exchanged every 3~6 month. It is set to bypass in summer (Bypass setting: High threshold 24.0℃, Lower threshold 18.0℃). ISO defroster heater is also installed. Effective heat recovery efficiency is 81.2%, and humidity recovery efficiency is 73%.

8. Heat supply system

Floor heating is served in the Pangyo Passivhaus. A gas condensing boiler generates heating water and domestic hot water. Its heating power and DHW power is about 30kW. It is too much power for passivhaus of heating load 11.5 W/m², but in Korea there are no small power boiler products suitable for passivhaus



9. PHPP calculations

Passive House Verification

Building:	Pangyo PassivHaus		
Street:	49-1, Pangyo-ro 209beon-gil, Bundang-gu		
Postcode/City:	13473	Seongnam-si	
Province/Country:	Gyeonggi-do	KR-Korea, Republic of	
Building type:	Detatched Single Family House		
Climate data set:	KR0001a-Seoul		
Climate zone:	3: Cool-temperate	Altitude of location:	65 m
Home owner / Client:	Byoung-Eun Jeong		
Street:	49-1, Pangyo-ro 209beon-gil, Bundang-gu		
Postcode/City:	13473	Seongnam-si	
Province/Country:	Gyeonggi-do	KR-Korea, Republic of	

Architecture:	Byoung-Eun Jeong		
Street:	49-1, Pangyo-ro 209beon-gil, Bundang-gu		
Postcode/City:	13473	Seongnam-si	
Province/Country:	Gyeonggi-do	KR-Korea, Republic of	
Energy consultancy:	Pil-Ryul Lee		
Street:	22-4, Changuimun-ro 5ga-gil, Jongno-gu		
Postcode/City:	03022	Jongno-gu	
Province/Country:	Seoul	KR-Korea, Republic of	

Mechanical engineer:	Pil-Ryul Lee		
Street:	22-4, Changuimun-ro 5ga-gil, Jongno-gu		
Postcode/City:	03022	Jongno-gu	
Province/Country:	Seoul	KR-Korea, Republic of	
Certification:	Energie- und Umweltzentrum Allgäu		
Street:	Burgstraße 26		
Postcode/City:	87435	Kempten	
Province/Country:	Bayern	DE-Germany	

Year of construction:	2015	Interior temperature winter [°C]:	20.0	Interior temp. summer [°C]:	25.0
No. of dwelling units:	1	Internal heat gains (IHG) heating case [W/m²]:	2.3	IHG cooling case [W/m²]:	2.3
No. of occupants:	3.1	Specific capacity [Wh/K per m² TFA]:	60	Mechanical cooling:	x

Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	225.6				
Space heating	Heating demand	kWh/(m²a)	13	≤	15	-	yes
	Heating load	W/m²	11	≤	-	10	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	11	≤	18	18	yes
	Cooling load	W/m²	7	≤	-	10	
	Frequency of overheating (> 25 °C)	%	-	≤	-		-
	Frequency of excessively high humidity (> 12 g/kg)	%	0	≤	10		yes
Airtightness	Pressurization test result n_{50}	1/h	0.3	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	69	≤	-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	63	≤	60	63	yes
	Generation of renewable energy (in relation to pro-jected building footprint area)	kWh/(m²a)	44	≥	-	5	

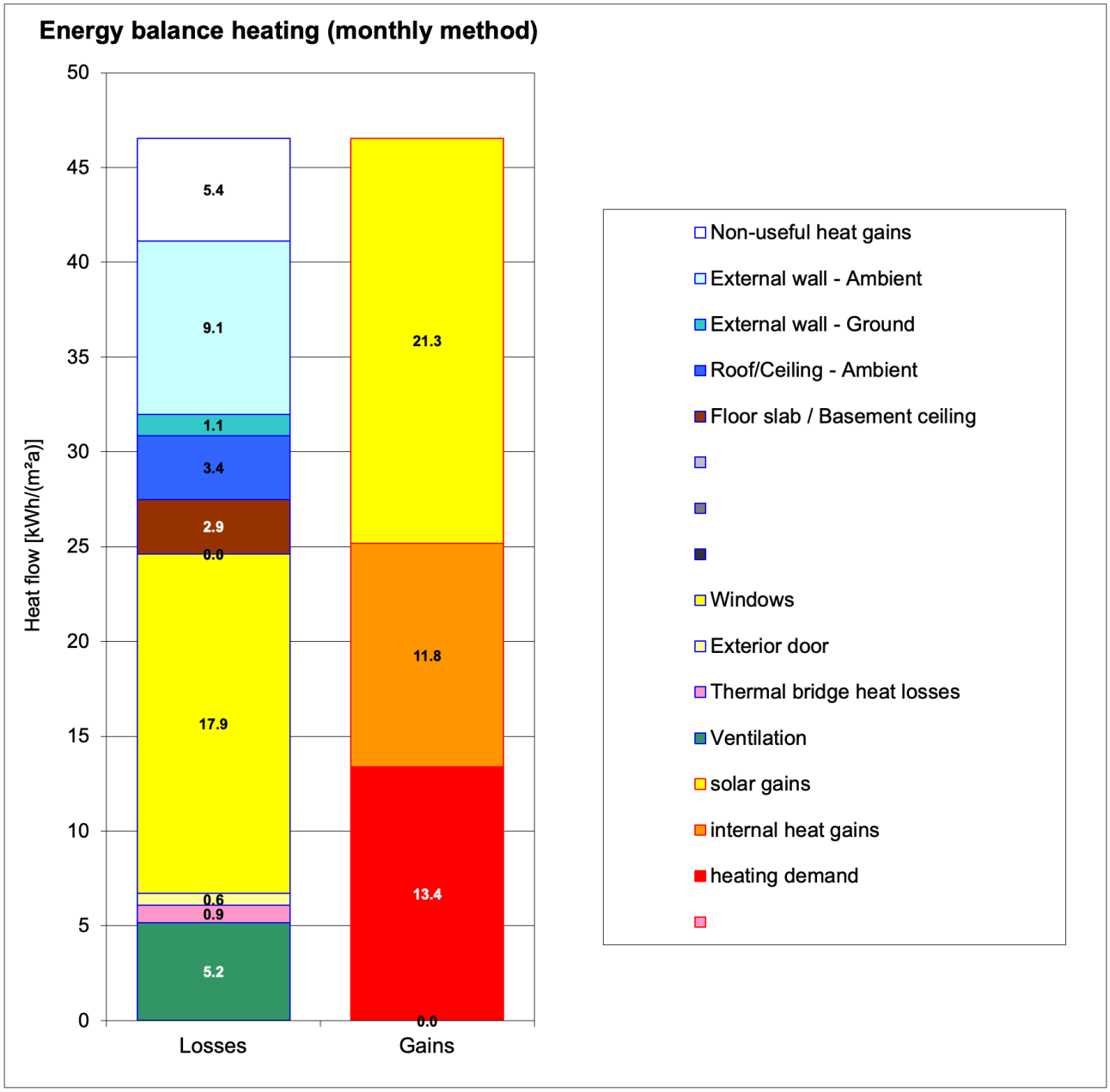
[2] Empty field: Data missing; '-': No requirement

I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

Passive House Classic? yes

Task:	First name:	Surname:	Signature:
1-Designer	Wooseok	Choe	

Issued on: City:



The windows account for almost half of the heat losses. Heat losses from windows double those that come from walls because of the large window area and super-insulated walls. On the contrary, almost half of the losses are compensated again by the solar gains through the windows.

10. Construction costs

Whole costs of construction was approximately 2,000 Euro/m² (2,800,000 Won/m²). The additional costs for energy efficiency were estimated about 413 Euro/m² (580,000 Won/m²) or about 21% of the construction costs. It is consisted of the insulation cost 140 Euro/m² (200,000 Won/m²), the ventilation cost 48 Euro/m² (67,000 Won/m²), the window cost 194 Euro/m² (270,000 Won/m²), and the airtightness cost 32 Euro/m² (45,000 Won/m²).

	Euro per unit area	Won per unit area	
Construction costs	€2,000	₩2,800,000	100.0%
Additional costs for energy efficiency	€414	₩580,000	20.7%
Insulation costs	€140	₩200,000	7.0%
Ventilation costs	€48	₩65,000	2.4%
Windows costs	€194	₩270,000	9.7%
Airtightness costs	€32	₩45,000	1.6%