

Plus Energy Building in Estonia

Georg W. Reinberg,

Architekturbüro Reinberg, ZT GesmbH, Wien

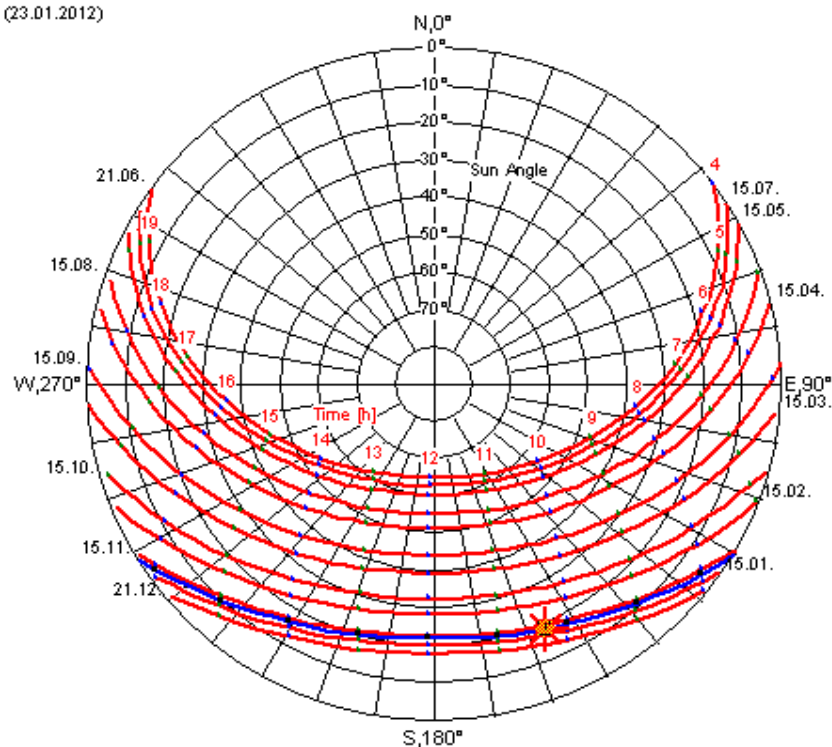
Tõnu Märing,

University of Tartu, Tartu Ülikooli tehnoloogia instituut



Austria (Wien), 23.01.2012

☀ Actual sun location
(23.01.2012)

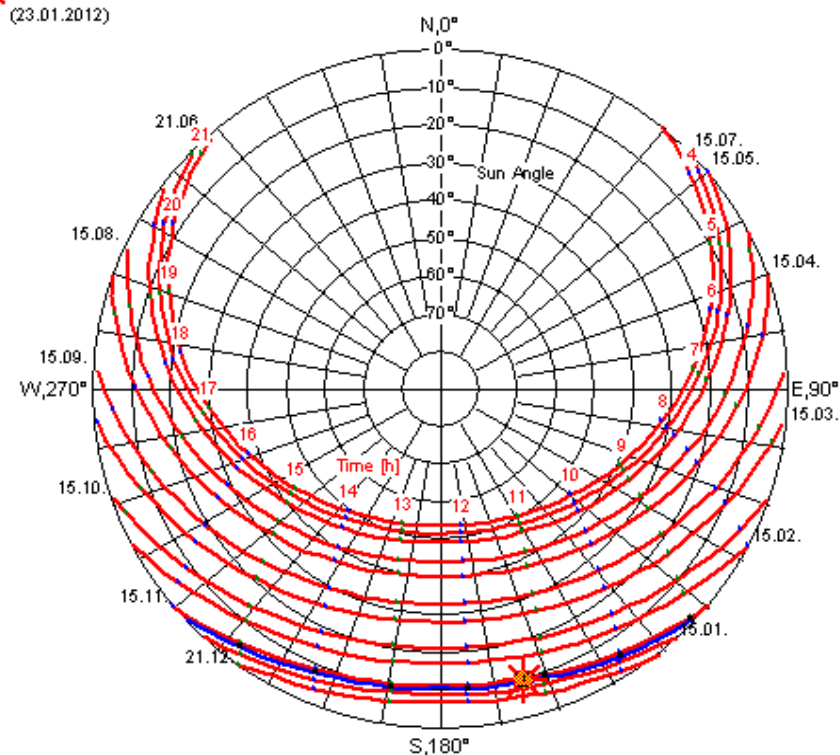


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Landeshauptstadt Stuttgart, Amt für Umweltschutz, Abt. Stadtklimatologie

Ver. 2.2 29.06.07 tf

Tallinn, 23.01.2012

☀ Actual sun location
(23.01.2012)



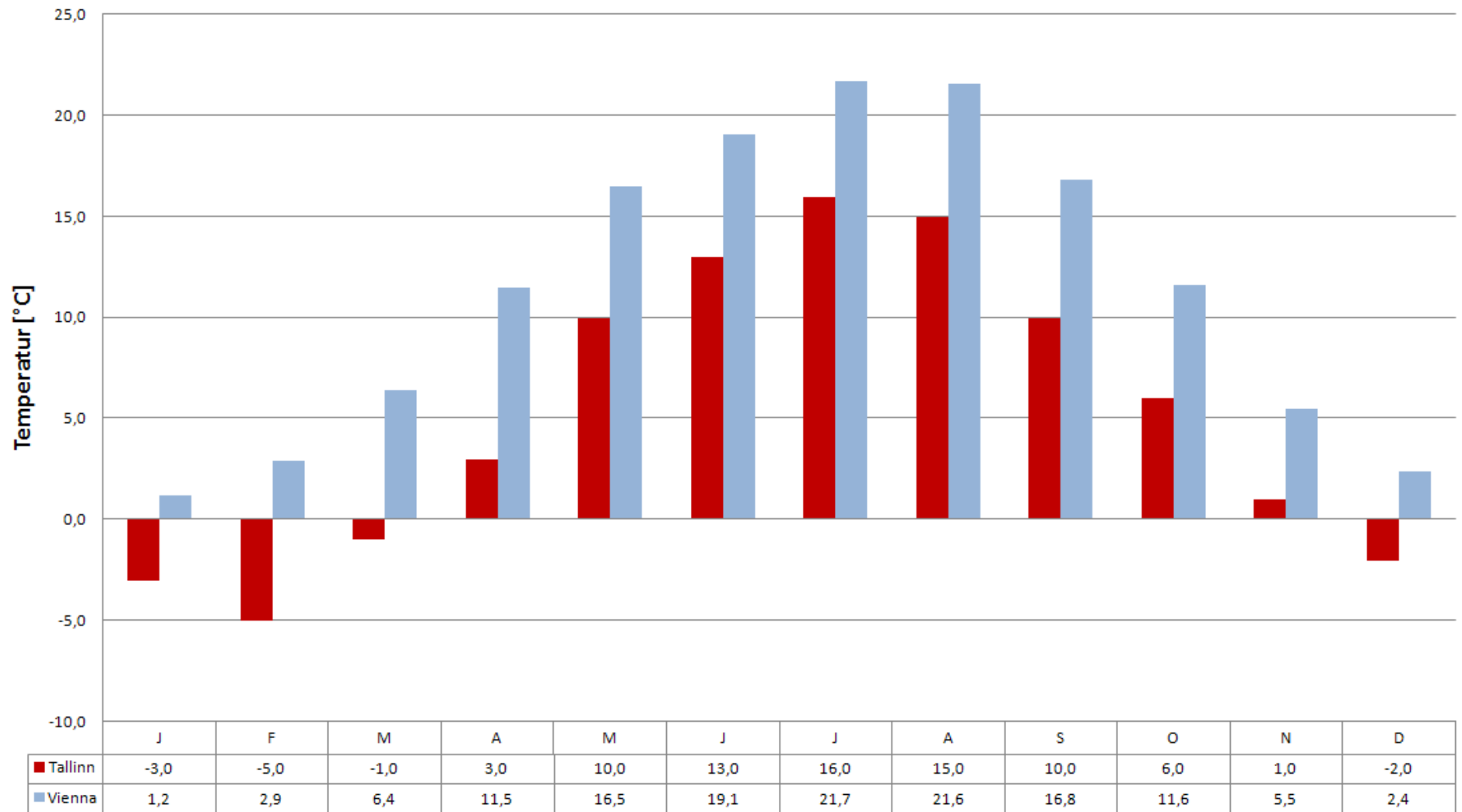
(C) 2007 Lohmeyer GmbH & Co. KG, Karlsruhe
Landeshauptstadt Stuttgart, Amt für Umweltschutz, Abt. Stadtklimatologie

Ver. 2.2 29.06.07 tf

Quelle:

- Vienna: Climate Data ZAMG 1971-2001, www.zamg.ac.at 08.2011
- Tallinn: <http://www.climatedata.eu>, <http://www.weatherbase.com> 01.2012

Monthly Mean Temperatur



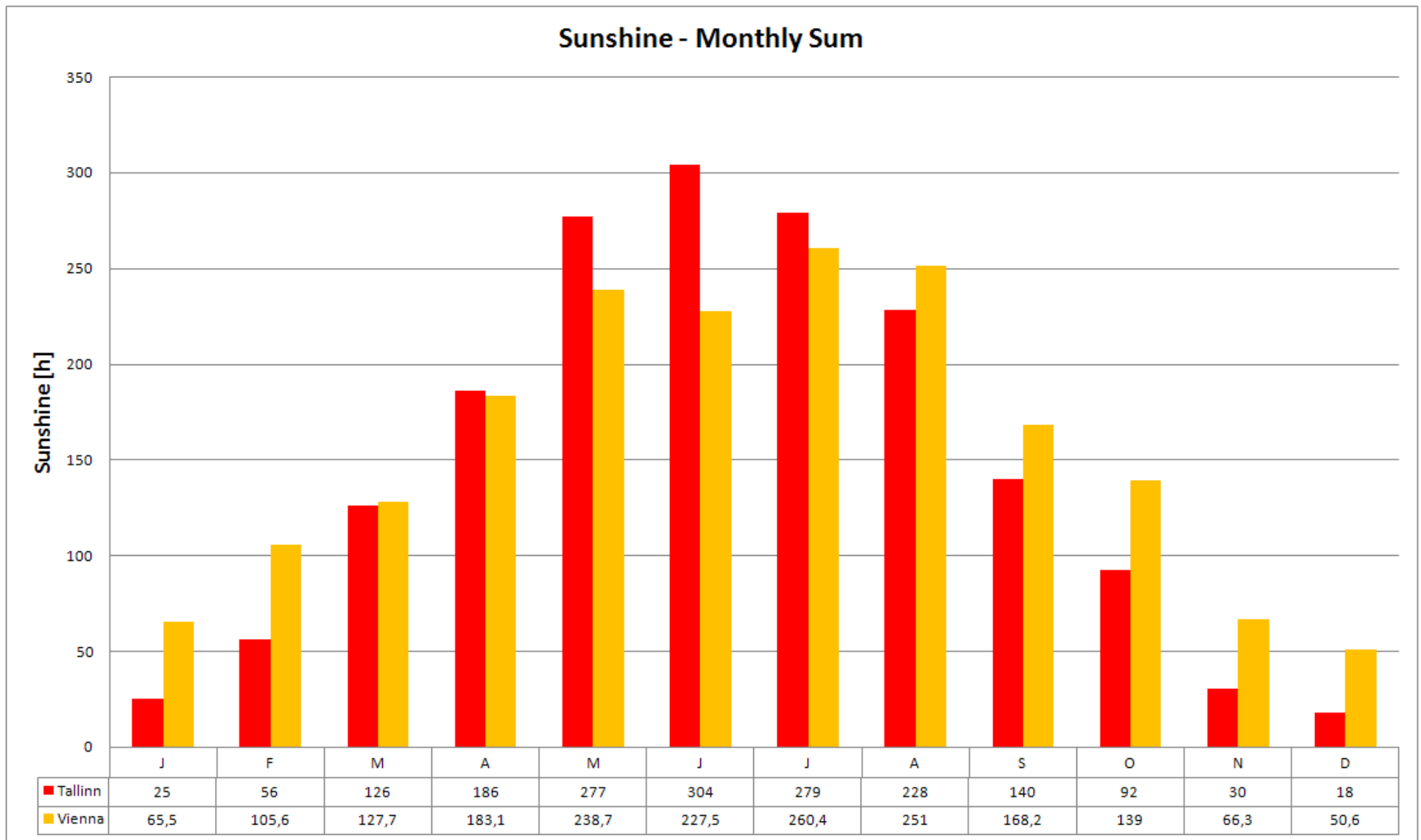
DATA FROM

Vienna:

Climate Data ZAMG 1971-2001, www.zamg.ac.at 08.2011

Tallinn:

<http://www.climatedata.eu>, <http://www.weatherbase.com> 01.2012



DATA FROM

Vienna:

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<http://www.climatedata.eu>, <http://www.weatherbase.com> 01.2012

Plus Energy Building in Estonia

- 1) PLANNING**
- 2) BUILDING**
- 3) RESULTS**

1) PLANNING

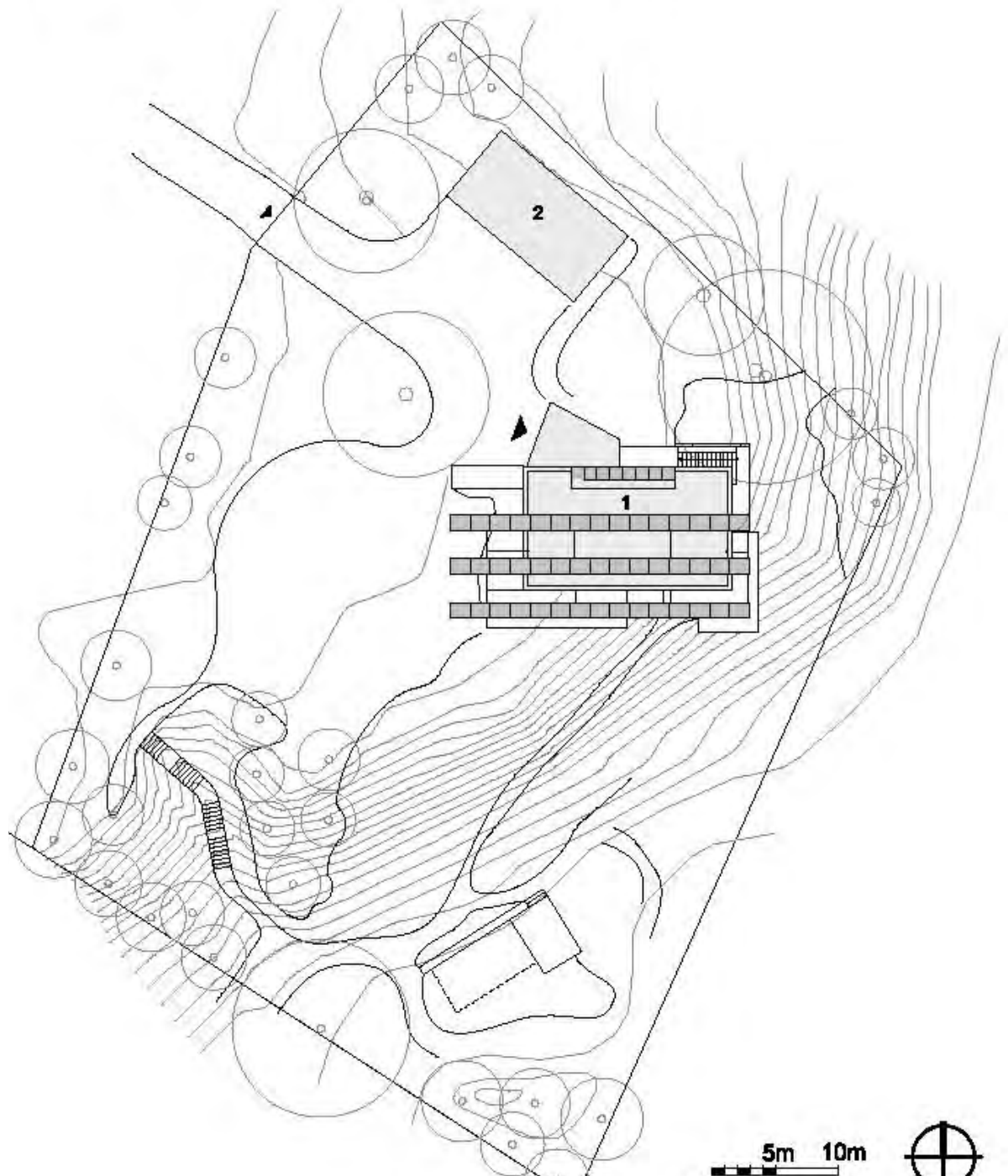


- Treated floor area according to PHPP: 285 m²/Volume 1.222 m³
- Construction time: 10/2011 – 04/2013
- Adress: Põlva, Metsa tn. 5a, (near Tartu)

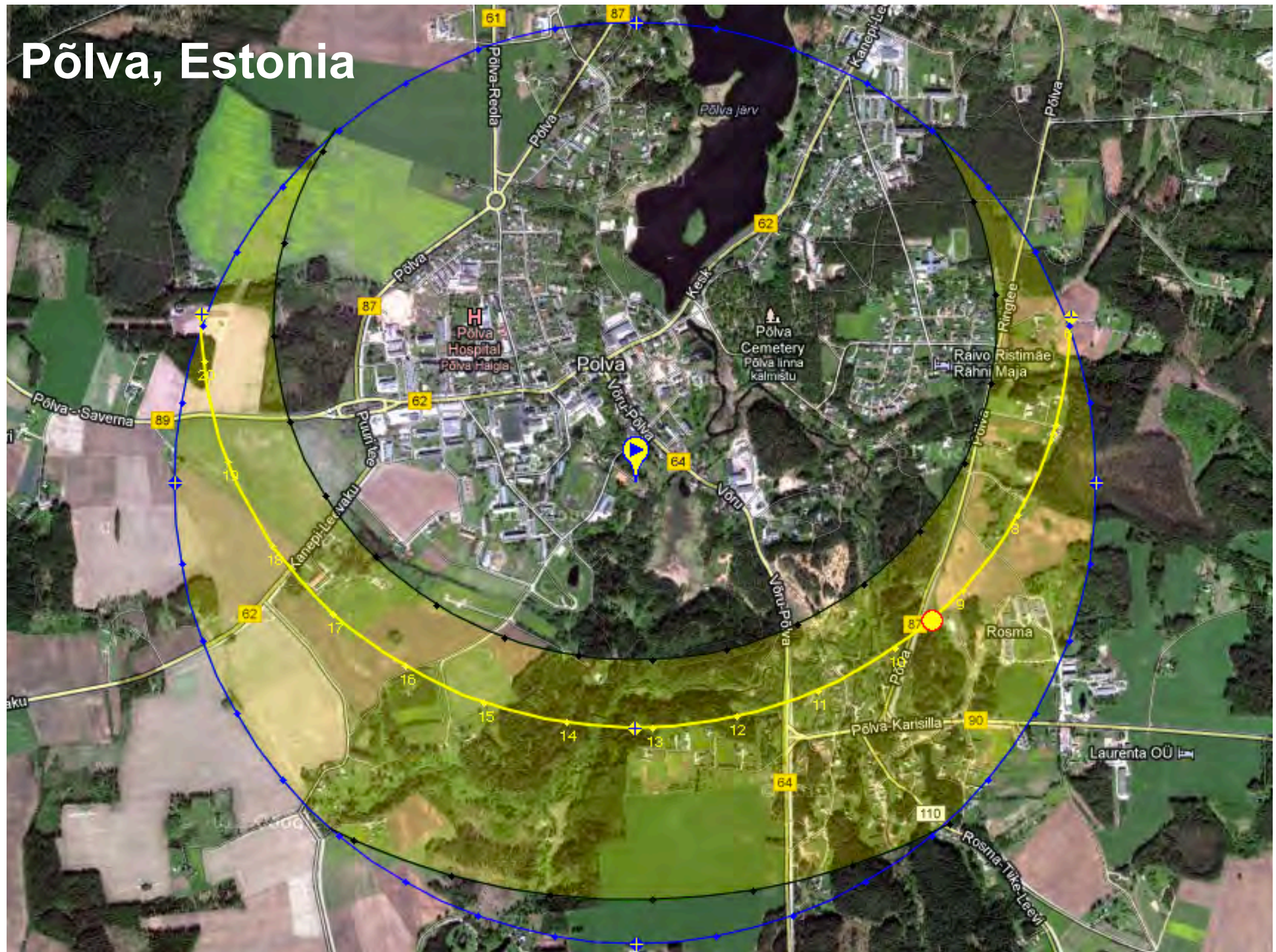
- Architects: Martha Enriquez Reinberg and Georg W. Reinberg, Architekturbüro Reinberg ZT GmbH, Wien

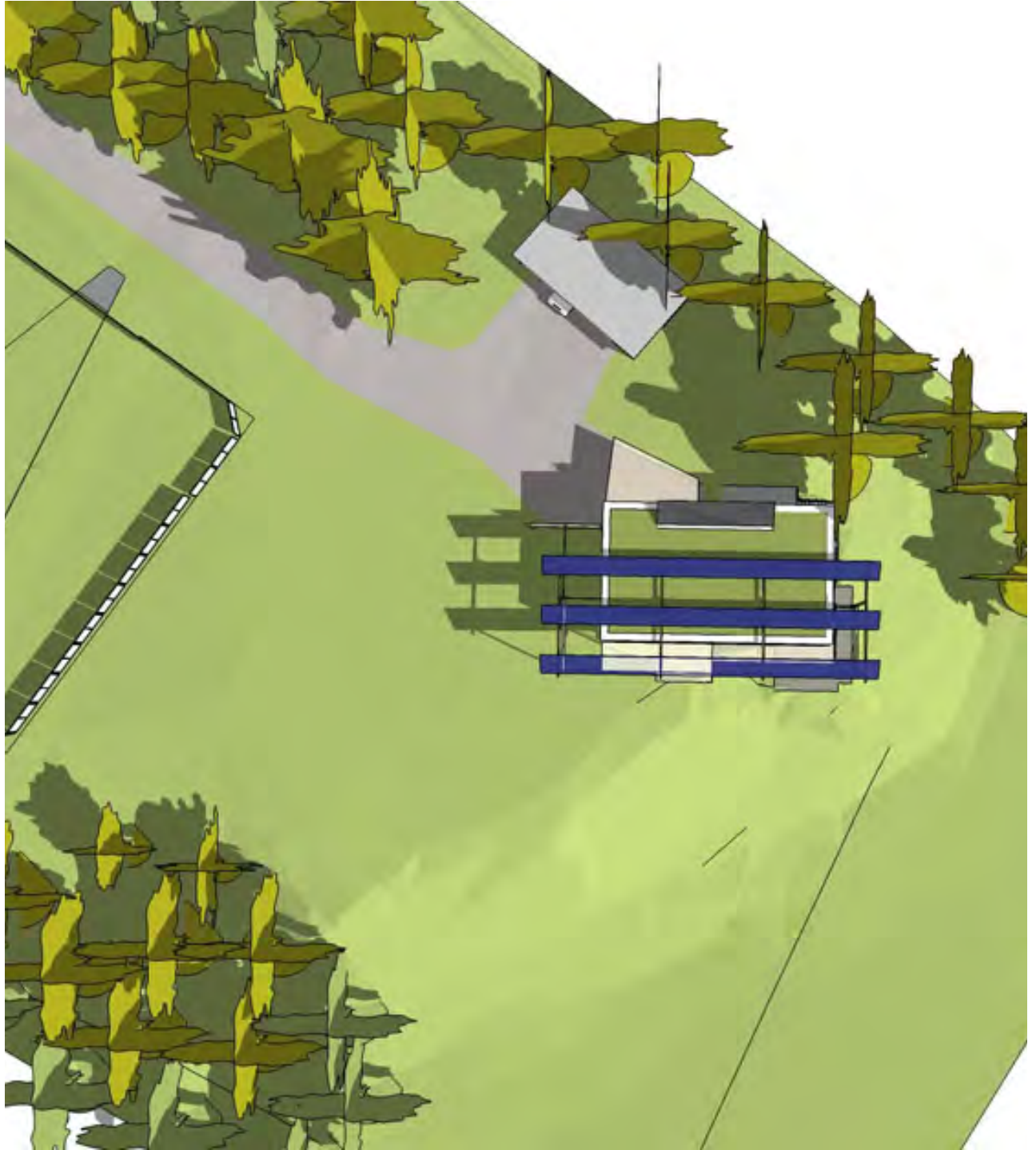
Consulters:

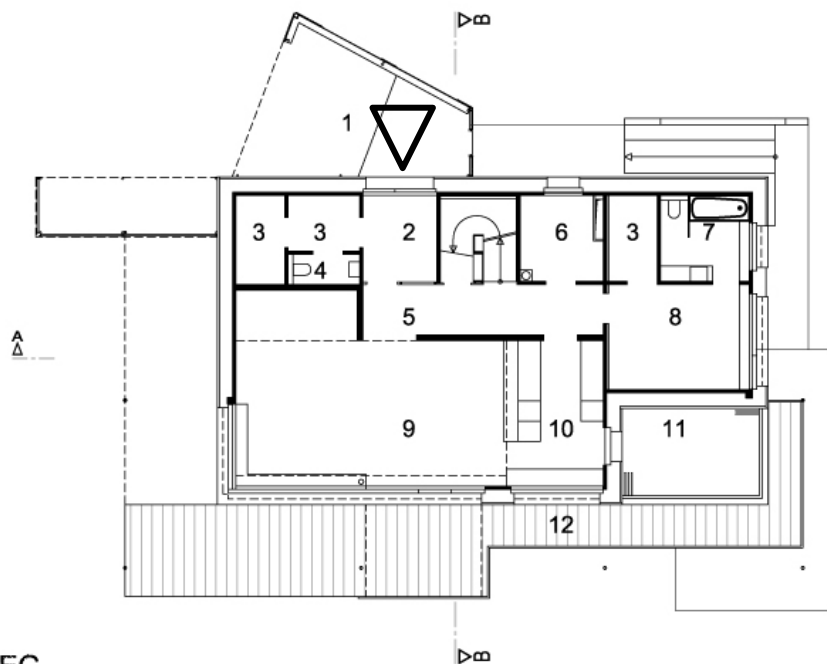
- Tõnu Mäuring, Jaanus Hallik and Kristo Kalbe, University of Tartu (building physics, monitoring), Johannes Riebenbauer, Graz (static engineer),
- S&P Climadesign GmbH (Haustechnik),
- Margus Valge, Sense OÜ (project management and site supervision),
- PassiveHouse OÜ, Estonia and Passive House Institute, Darmstadt (Certification).



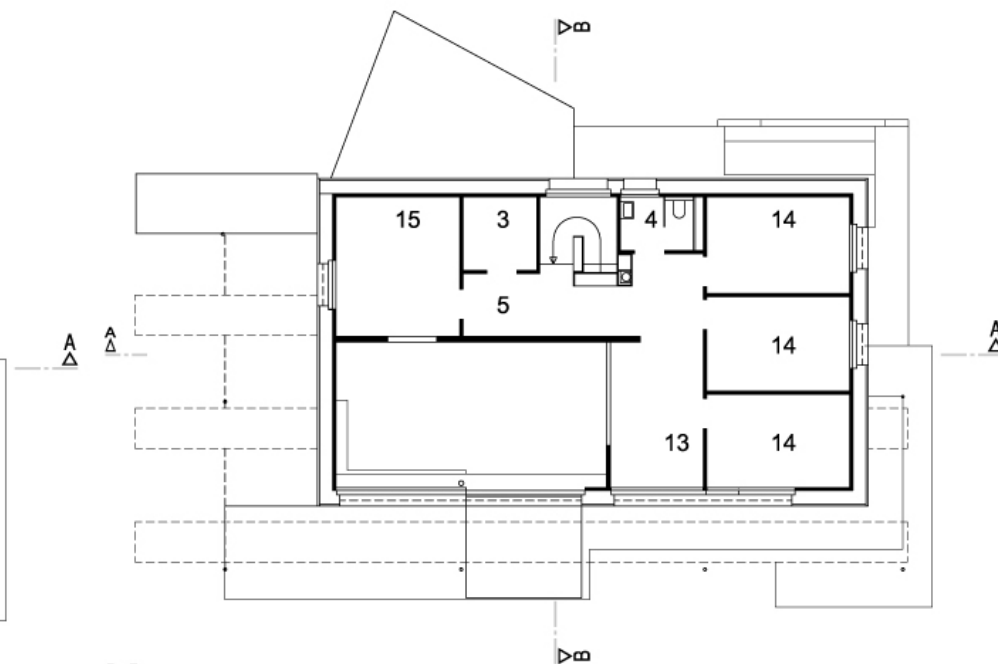
Põlva, Estonia



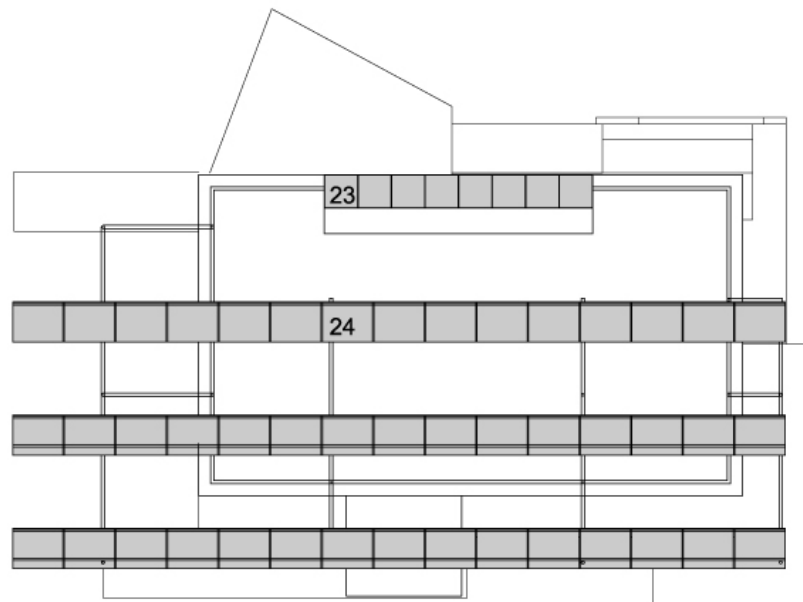




EG

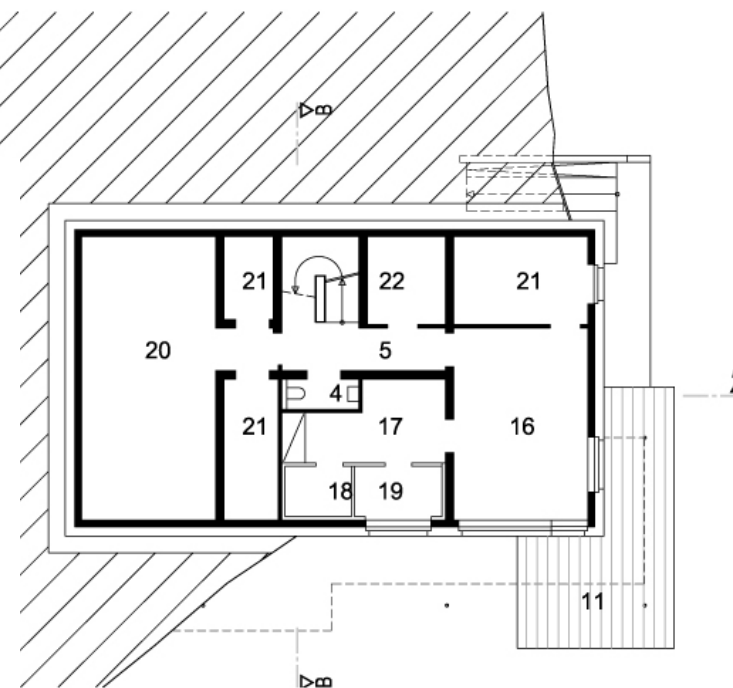


OG



D

1. cover space
2. Entrance
3. Wardrobe
4. WC
5. Corridor
6. Laundry room
7. Bathroom
8. Master Bedroom
9. Livingroom
10. Kitchen
11. Conservatory
12. Terrace
13. Gallery
14. Children room
15. Study room
16. Recreation room
17. Shower room
18. Steambath
19. Sauna
20. Playroom
21. Storage room
22. Thecnic room
23. Therm.Solar Coll.
24. PV

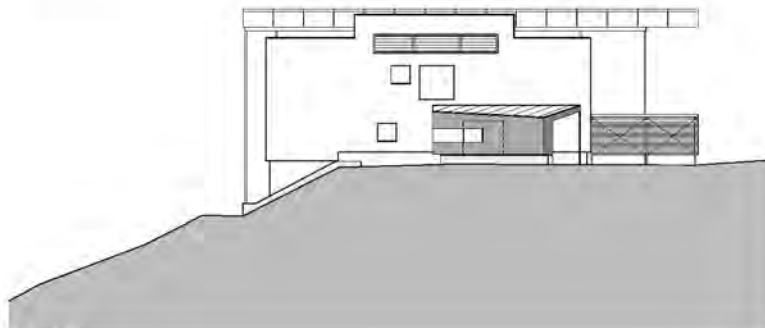




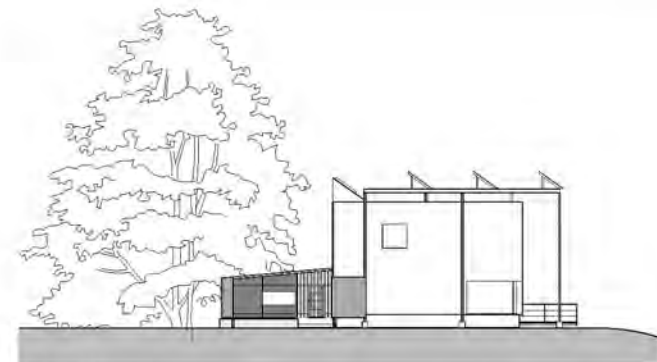
S Ansicht



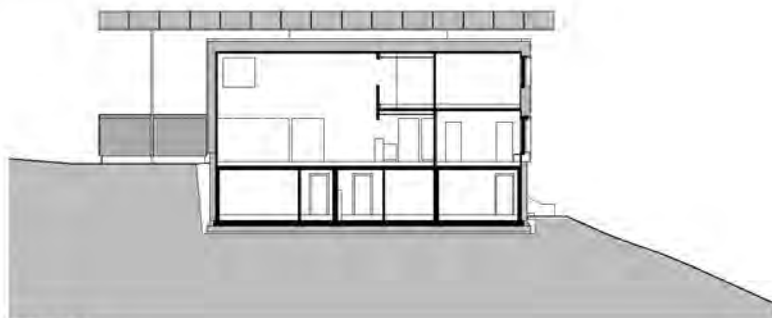
O Ansicht



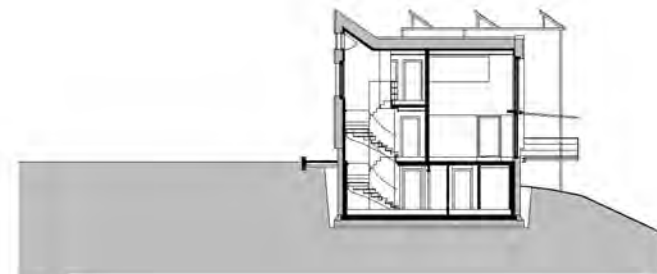
N Ansicht



W Ansicht



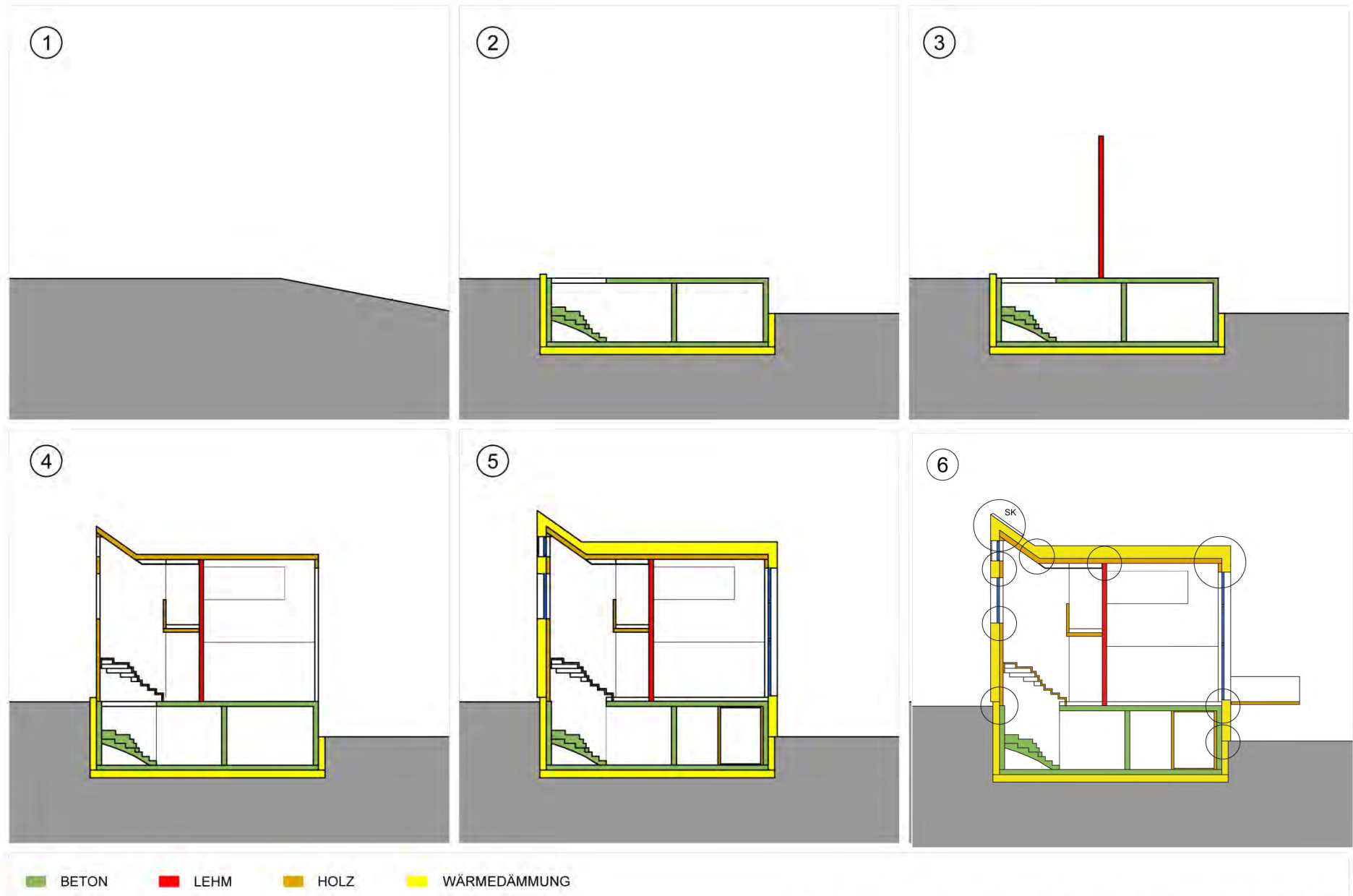
Schnitt A.A.



Schnitt B.B.



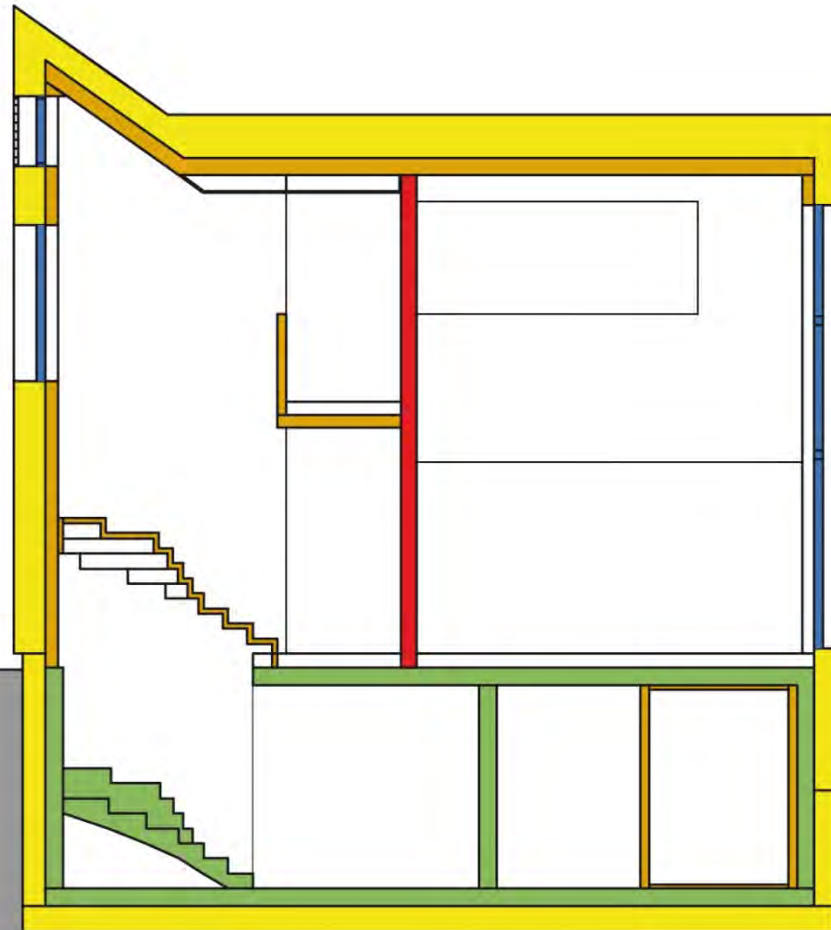




4



5



Wall

400 mm cellulose fiber, 94 mm KLH

Massive wood, $U = 0,105$ W/(m²K)

Ceiling

500 mm EPS, 102 mm KLH

$U = 0,079$ W/(m²K)

Wall, underground

500 mm EPS, 200 mm concrete

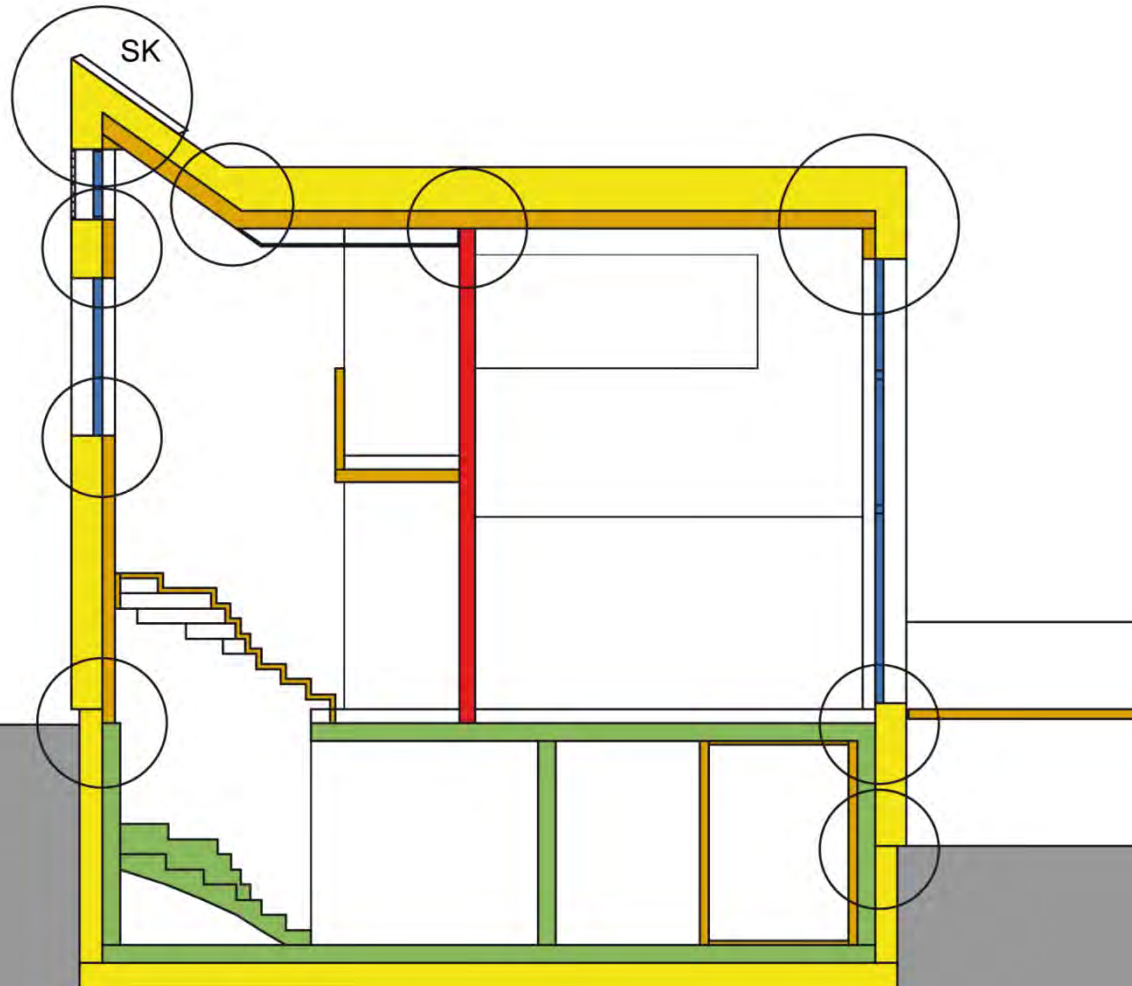
$U = 0,066$ W/(m²K)

Floor

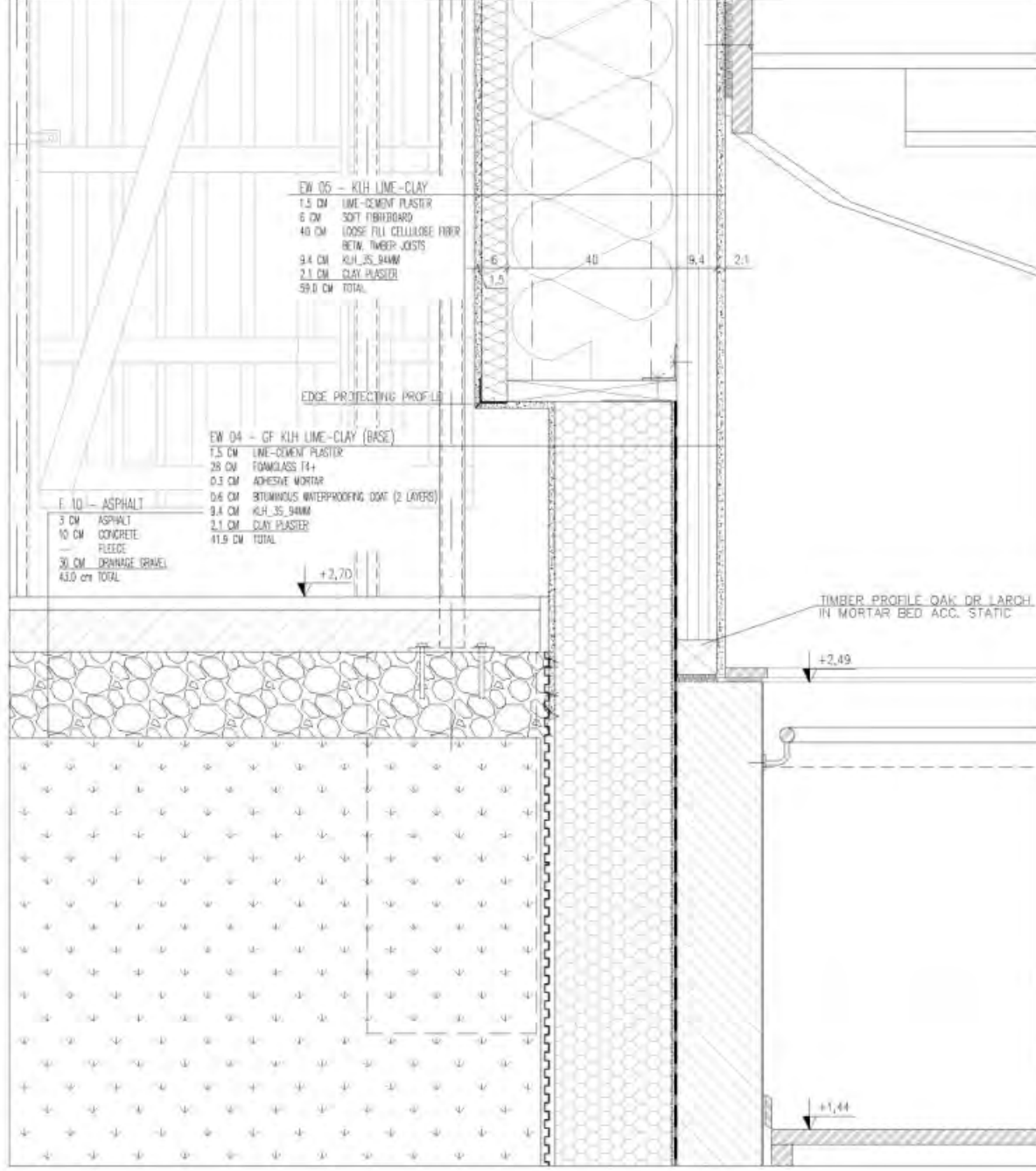
300 mm XPS, 300 mm concrete,
100 mm EPS

$U = 0,086$ W/(m²K)

6



➡ Passiv House



PROJEKT
STATIK

PROJEKT
BAUWERK

PROJEKT
HAUSTECHNIK

KOTLIN PROFEN - NATURMASSE NEHMEN

SÄMTLICHE DIMENSIONEN SIND RICHTWERTE. STATISCHE NACHWEISE SIND VOM AUFTRAGNEHMER ZU ERBRINGEN.
ABWEICHUNGEN IN DEN ABMESSUNGEN KÖNNEN NICHT ZU MEHRKOSTEN FÜHREN.

PROJEKT
ESTLAND - PÖLVA

INHALT
PERIMETER BASE - IN PORCH
ARCHITEKTURBÜRO SPRINGER ZT MCHH A-11100 WIEN 1 BÜROFLÄCHE 30,7110

F
E
D
C
B

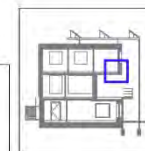
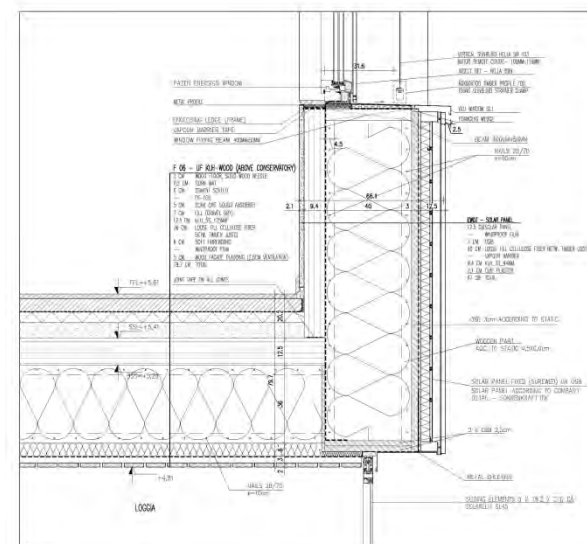
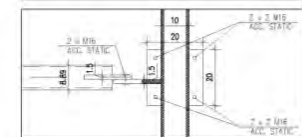
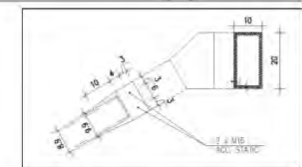
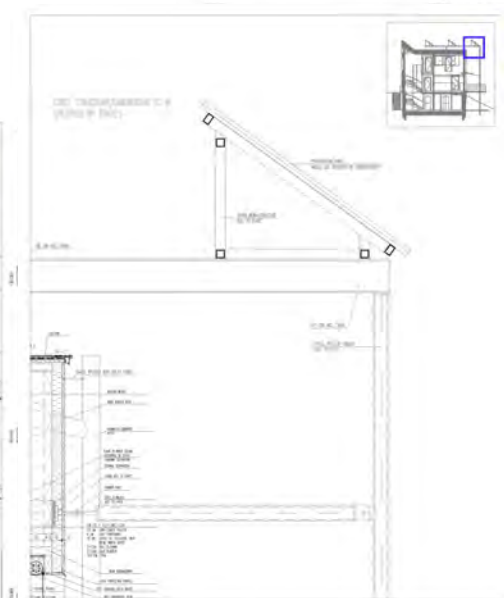
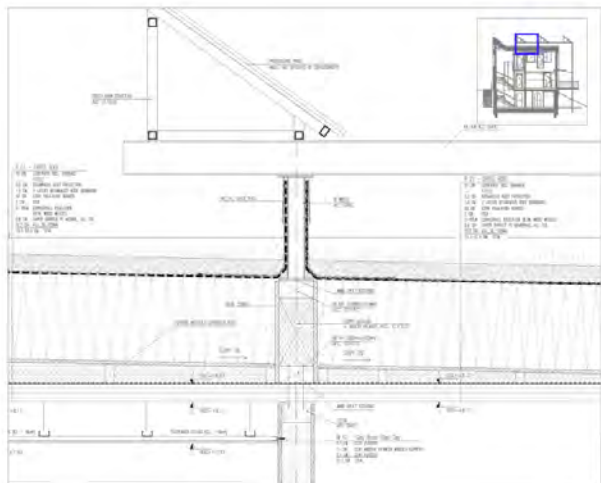
VORABZUG

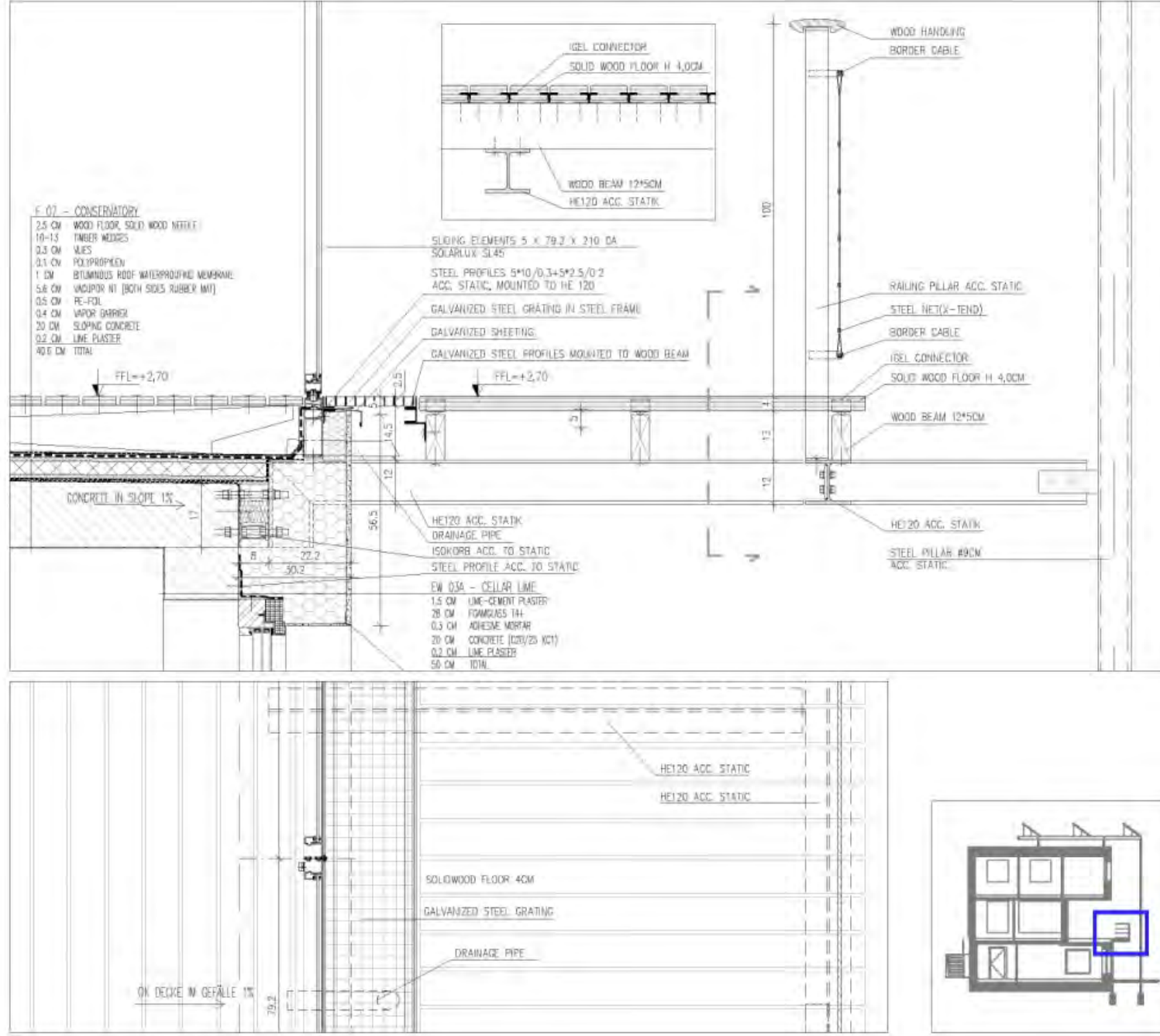
PROJ. 265

PLANNR. D13

MASZSTAB
DATUM
CET

1:10
28.09.2011
MD





REKONSTRUKTION
STATIK

REKONSTRUKTION
Bauherr

REKONSTRUKTION
Architekt

SÄMTLICHE DIMENSIONEN SIND RICHTWERTE, STATISCHE NACHWEISE SIND VOM AUFTRAGNEHMER ZU ERBRINGEN.
ABWEICHUNGEN IN DEN ABMESSUNGEN KÖNNEN NICHT ZU MEHRKÖSTEN FÜHREN.

KÖTEN PRÜFEN - NATURMASSE NEHMEN

PROJEKT
ESTLAND - PÖLVA

INHALT
GROUND FLOOR TERRACE+ CONSERVATORY

ARCHITEXTURBÜRO REINBERG ZT GMBH, A-1070 WIEN, LINDENGASSE 39/10
TEL. 01/524 82 80-0, FAX. 01/524 82 80-1, E-MAIL: ARCHITEXT@REINBERG.NET

F E D C B A

VORABZUG

PROJ. 265
MASZTAB
DATUM
GEZ.
DEPR.

PLANNR. D09
1:10
04.10.2011
MP
GEPRÜFT

All calculated psi-values for the project used in PHPP

Thermal Bridge Inputs												
No. of TB	Thermal Bridge Description	Group No.	Assigned to Group	Quantity	x (	User Determined Length [m]	-	User subtraction length [m]	)=	Length / [m]	Input of Thermal Bridge Heat Loss Coefficient W/(mK)	ψ W/(mK)
1	EW-EW	15	Thermal Bridges Ambient	1	x (	23,06	-		)=	23,06	EW-EW	-0,063
2	EW-EF	15	Thermal Bridges Ambient	1	x (	4,94	-		)=	4,94	EW-EF	-0,062
3	EW-EW inner	15	Thermal Bridges Ambient	1	x (	2,50	-		)=	2,50	EW-EW inner	0,027
4	EW-IC	15	Thermal Bridges Ambient	1	x (	38,50	-		)=	38,50	EW-IC	0,003
5					x (-)=			
6	EW-EW basement	15	Thermal Bridges Ambient	2	x (	2,95	-		)=	5,90	EW-EW basement	-0,054
7	EW-EW underground	17	Thermal Bridges Floor Slab	2	x (	2,95	-		)=	5,90	EW-EW underground	-0,050
8					x (-)=			
9	EW-R South	15	Thermal Bridges Ambient	1	x (	16,42	-		)=	16,42	EW-R South	-0,049
10	EW-R Centre (east/west)	15	Thermal Bridges Ambient	2	x (	9,77	-		)=	19,54	EW-R Centre (east/west)	-0,059
11	EW-R North	15	Thermal Bridges Ambient	1	x (	16,42	-		)=	16,42	EW-R North	-0,062
12					x (-)=			
13	VentR-EW	15	Thermal Bridges Ambient	1	x (	8,00	-		)=	8,00	VentR-EW	-0,110
14	VentR-R	15	Thermal Bridges Ambient	1	x (	8,00	-		)=	8,00	VentR-R	0,023
15	EW-EW vent	15	Thermal Bridges Ambient	2	x (	2,15	-		)=	4,30	EW-EW vent	-0,065
16					x (-)=			
17					x (-)=			
18					x (-)=			
19	EW-EW(bas)-CC	15	Thermal Bridges Ambient	1	x (	19,60	-		)=	19,60	EW-EW(bas)-CC	0,023
20	EW-CC	16	Perimeter Thermal Bridges	1	x (	32,50	-		)=	32,50	EW-CC	-0,007
21	EW-CF	16	Perimeter Thermal Bridges	1	x (	19,60	-		)=	19,60	EW-CF	-0,012
22					x (-)=			

An overall reduction by 1,92 kWh/(m2*year) to annual net heat demand was achieved compared to situation with no thermal bridge input.

Climate: PHI verified Tõravere, Estonia
 Building: SFH Metsa 5a, Põlva, Estonia
 Location: Tartu, Estland
 Spec. Capacity: 204 Wh/(m²K) (Enter in "Summer" worksheet.)

Interior Temperature: 20 °C
 Building Type/Use:
 Treated Floor Area ATFA: 284,5 m²

Building Element	Temperature Zone	Area m²	U-Value W/(m²K)	Month. Red. Fac.	Gt kWh/a	kWh/a	per m² Treated Floor Area
1. Exterior Wall - Ambient	A	307,0	0,104	1,00	94	2993	
2. Exterior Wall - Ground	B	105,3	0,066	1,00	52	364	
3. Roof/Ceiling - Ambient	A	160,1	0,071	1,00	94	1063	
4. Floor slab/ basement ceiling	B	151,0	0,086	1,00	52	681	
5.	A			1,00			
6.	A			1,00			
7. Conservatory	X	39,1	0,106	0,80	94	310	
8. Windows	A	97,1	0,656	1,00	94	5965	
9. Exterior Door	A	5,1	0,710	1,00	94	342	
10. Exterior TB (length/m)	A	167,2	-0,032	1,00	94	-505	
11. Perimeter TB (length/m)	P	52,1	-0,009	1,00	52	-24	
12. Ground TB (length/m)	B	5,9	-0,050	1,00	52	-15	

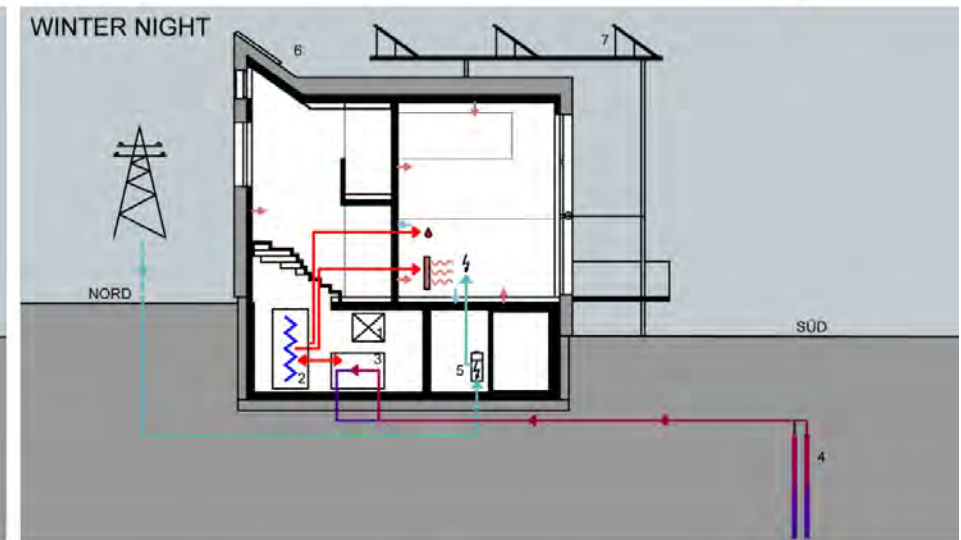
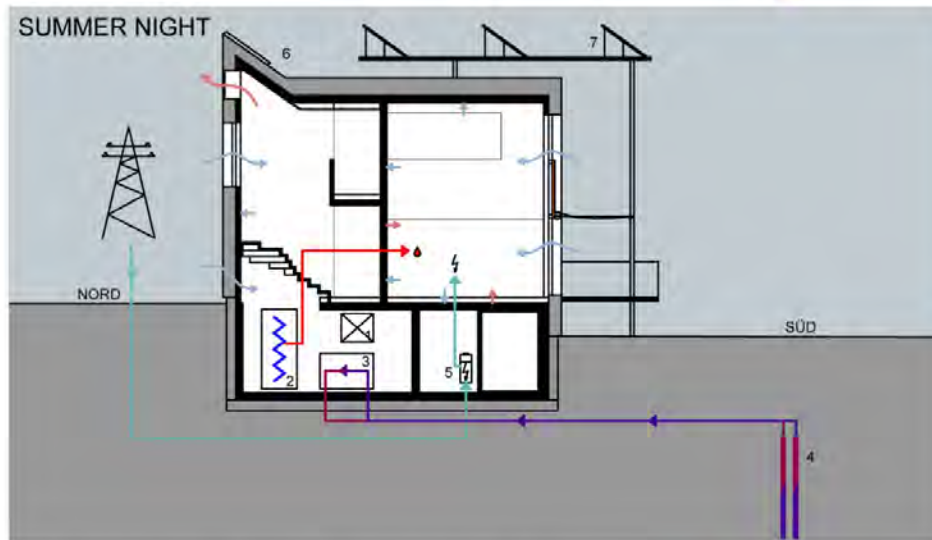
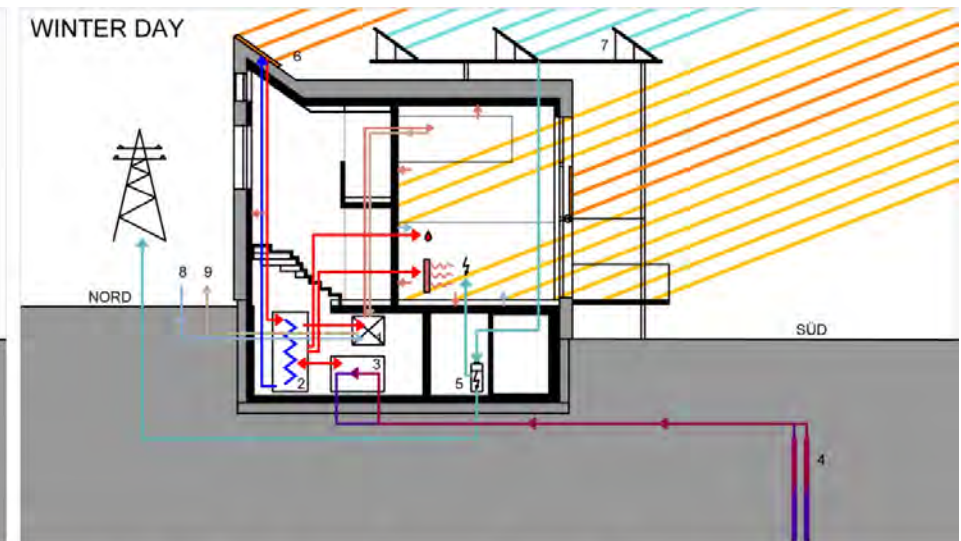
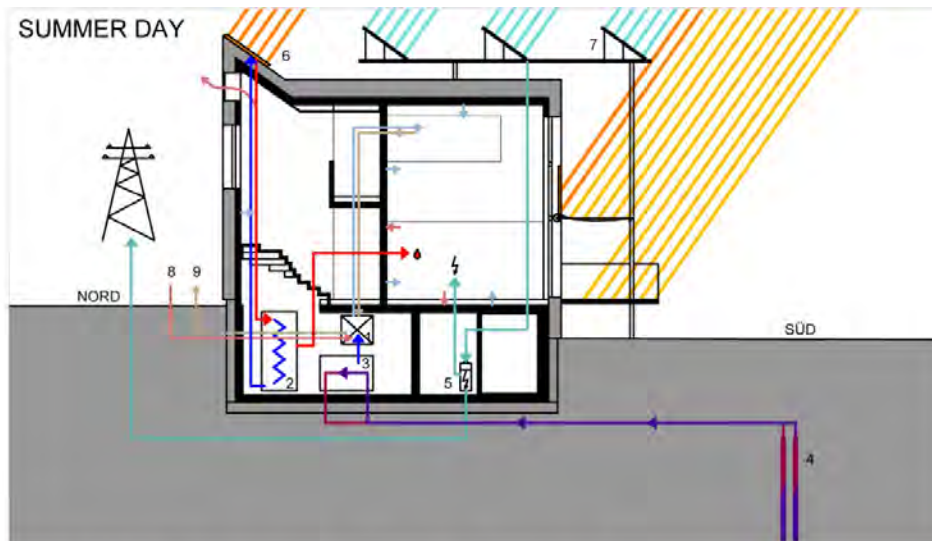
Transmission Heat Losses QT
 Ventilation Heat Losses QV
 Heat Gains QG

Total	11173	39,3
Total	1104	3,9
$\eta \Gamma * \Theta \Phi$	8318	29,2

Annual Heat Demand QH

QL - QG	3959	14
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Applied:	Monthly method	PH Certificate:	Fulfilled?
Specific Space Heating Demand:	14,71 kWh/(m²a)	15 kWh/(m²a)	Yes
Heating Load:	13 W/m²	10 W/m²	
Pressurization Test Result:	0,30 h⁻¹	0,6 h⁻¹	Yes
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	101 kWh/(m²a)	120 kWh/(m²a)	Yes
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	44 kWh/(m²a)		
Specific Primary Energy Reduction through Solar Electricity:	kWh/(m²a)		
Frequency of Overheating:	0 %	over 25 °C	
Specific Useful Cooling Energy Demand:	kWh/(m²a)	15 kWh/(m²a)	
Cooling Load:	2 W/m²		



- | | |
|-------------------|-----------------------|
| 1 LÜFTUNG MIT WRG | 6 SOLARANLAGE |
| 2 WASSERSPEICHER | 7 PHOTOVOLTAIK-ANLAGE |
| 3 WÄRMEPUMPE | 8 AUSSENLUFTANSAUGUNG |
| 4 FÖRDERBRUNNEN | 9 FORTLUFT |
| 5 ENERGIESPEICHER | |

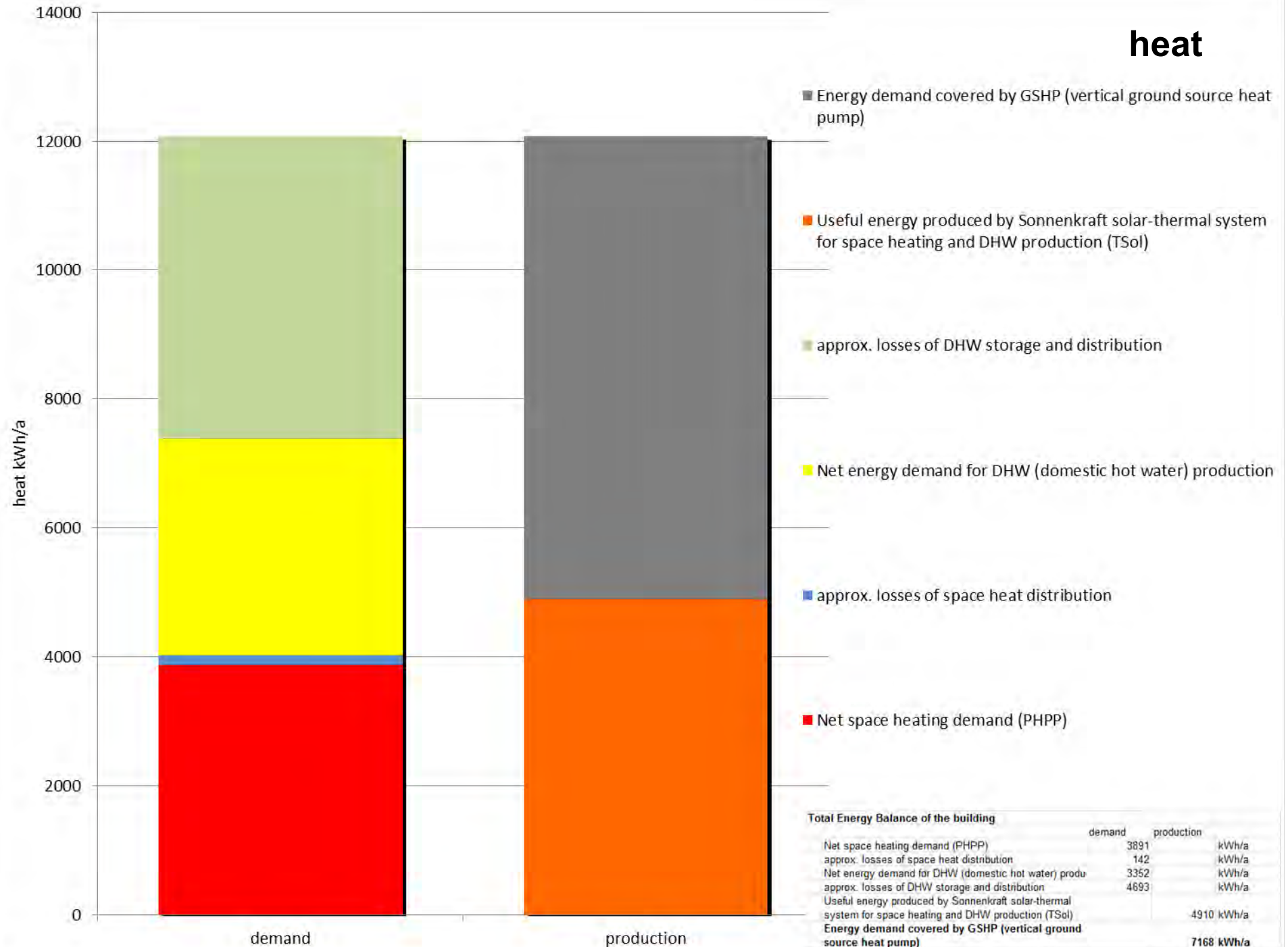
- | |
|---------------|
| → WARMWASSER |
| → KALTWASSER |
| → GRUNDWASSER |
| → WARM/KALT |
| → STROM |

- | |
|------------------|
| → ABLUFT |
| → WARME LUFT |
| → KALTE LUFT |
| → WÄRMESTRAHLUNG |
| → KALT/WARM |

- | |
|---------------------------------|
| → AKTIVE THERMISCHE NUTZUNG: SK |
| → AKTIVE THERMISCHE NUTZUNG: PV |
| → PASSIVE THERMISCHE NUTZUNG |

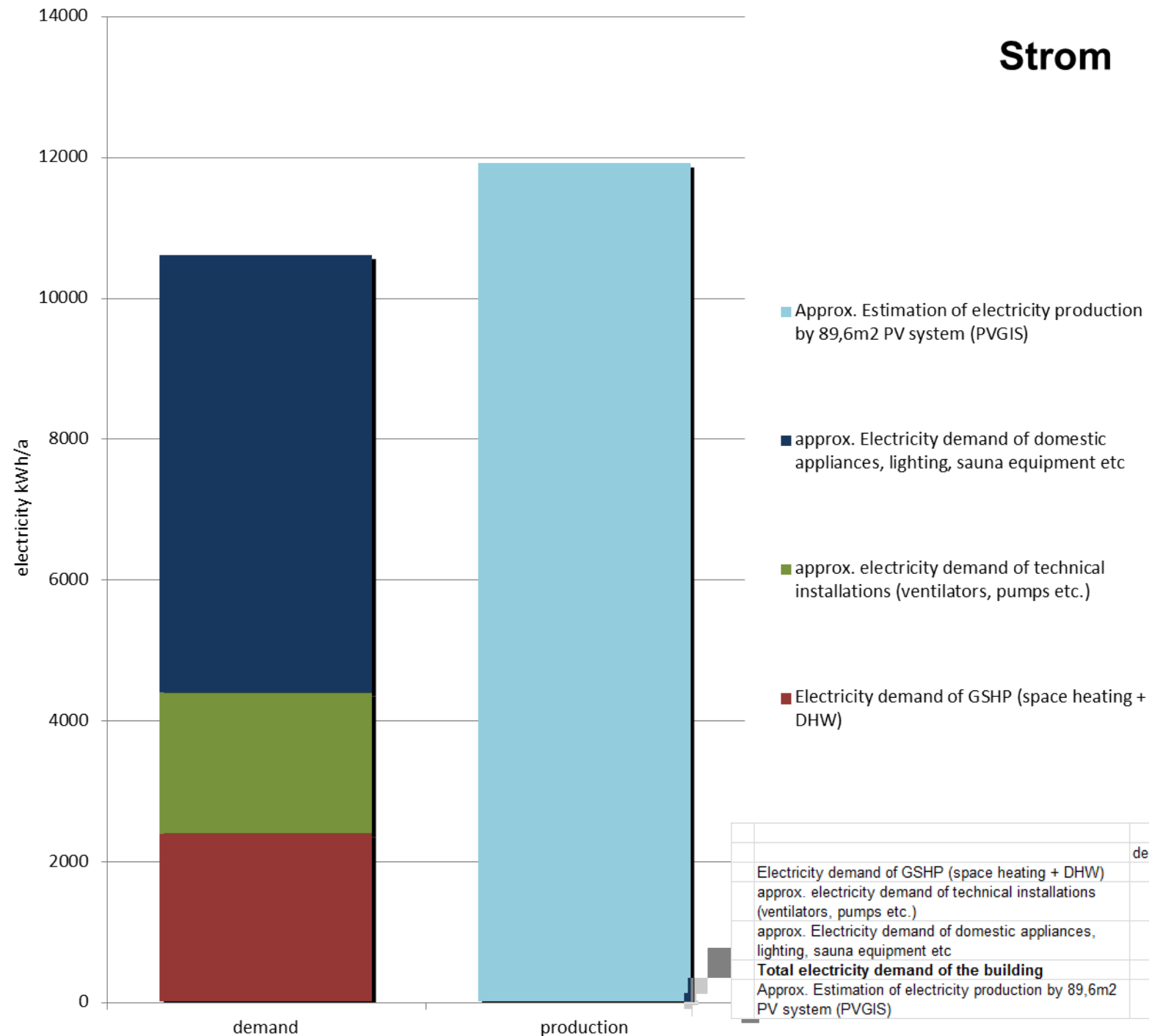
➡ Active House

heat

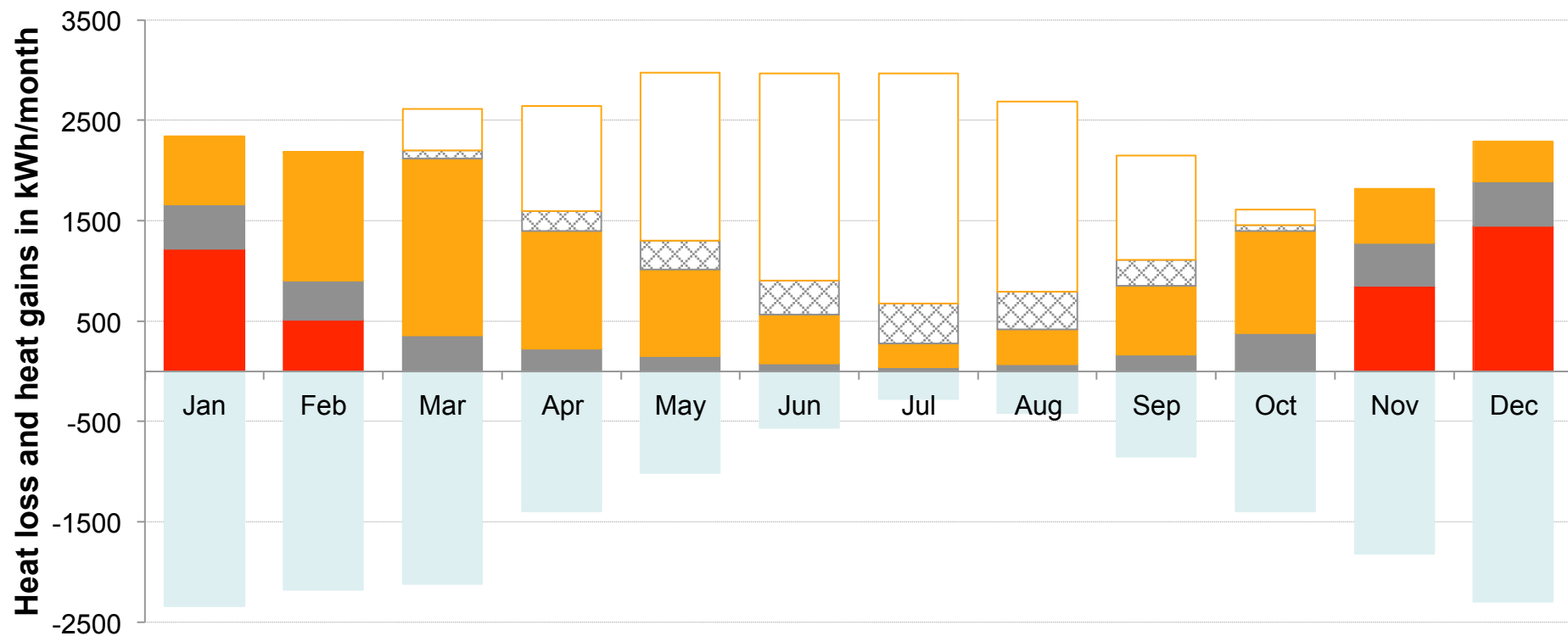


Strom

electricity



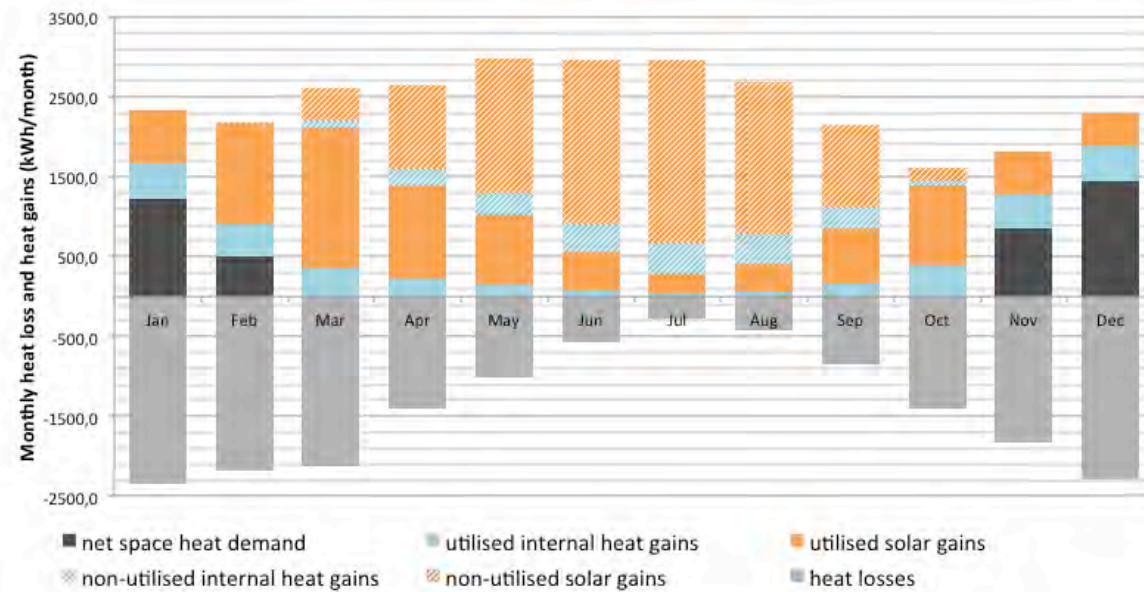
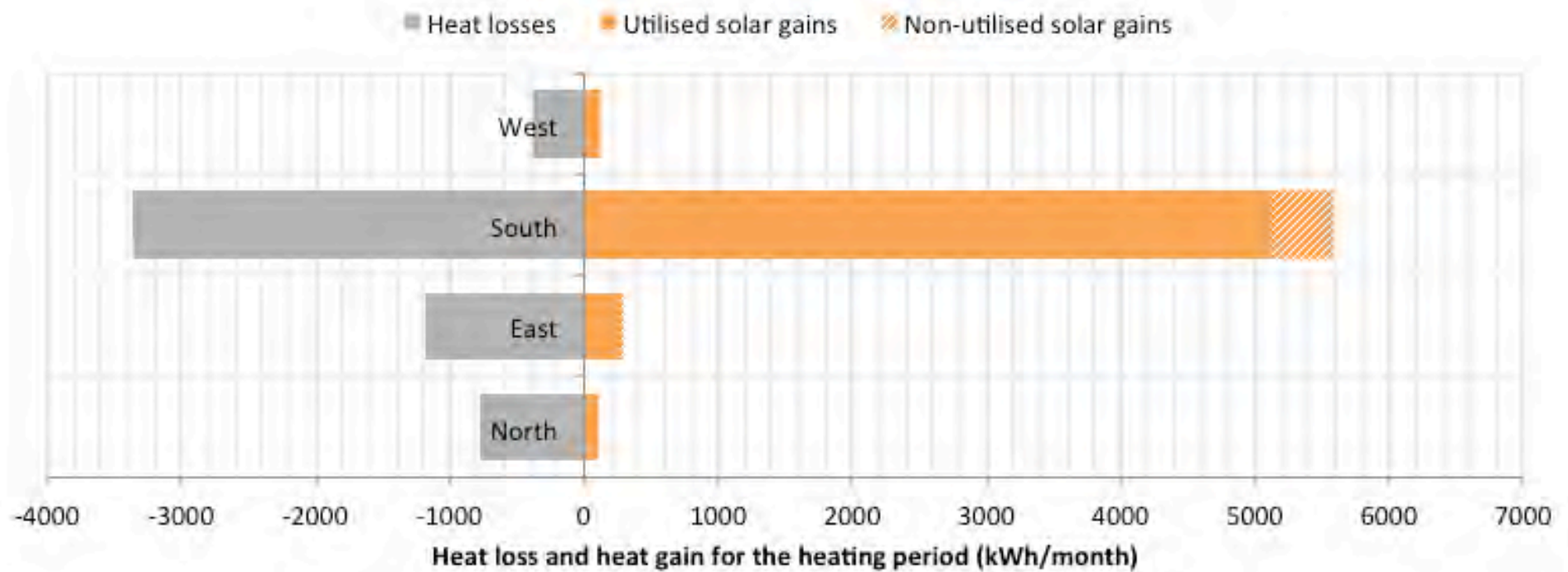
Building heat balance in kWh/month



■ Net space heat demand
■ Utilised solar gains

■ Utilised internal heat gains
▨ Non-utilised internal heat gains

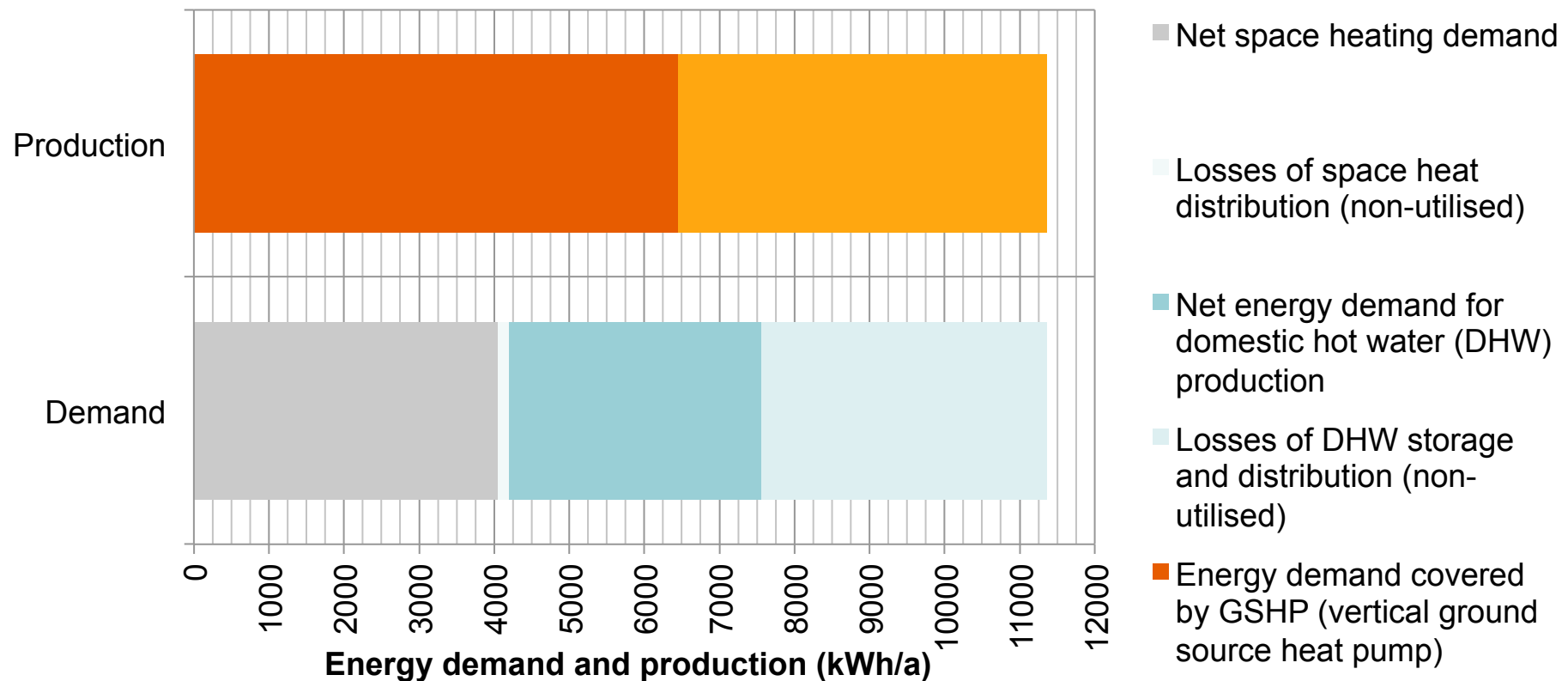
PHPP calculation



Estimated monthly heat losses and gains of the building (the effect of external movable shading elements are not taken into account for the summer months in this figure).

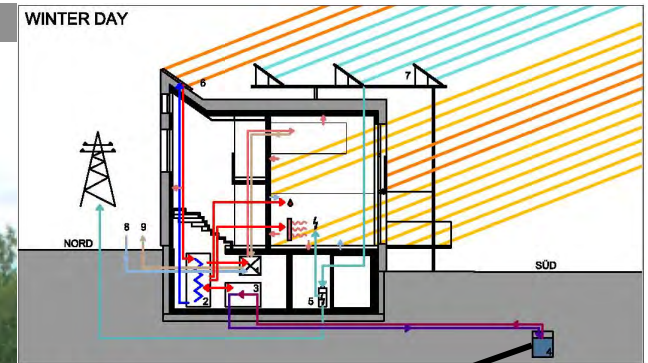
Whole building energy demand and production in kWh/a

Calculated values:



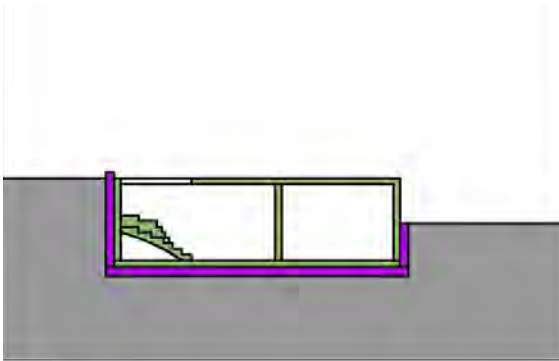


2) BUILDING









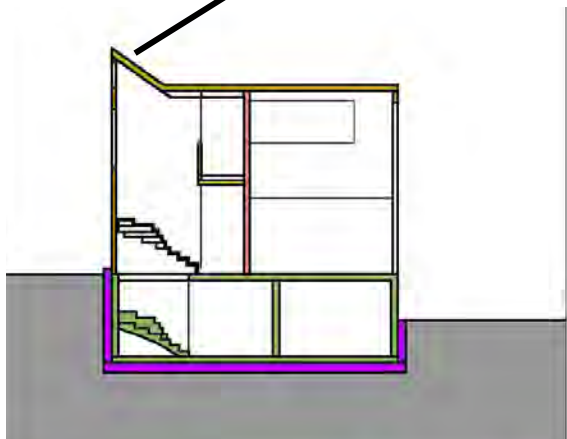
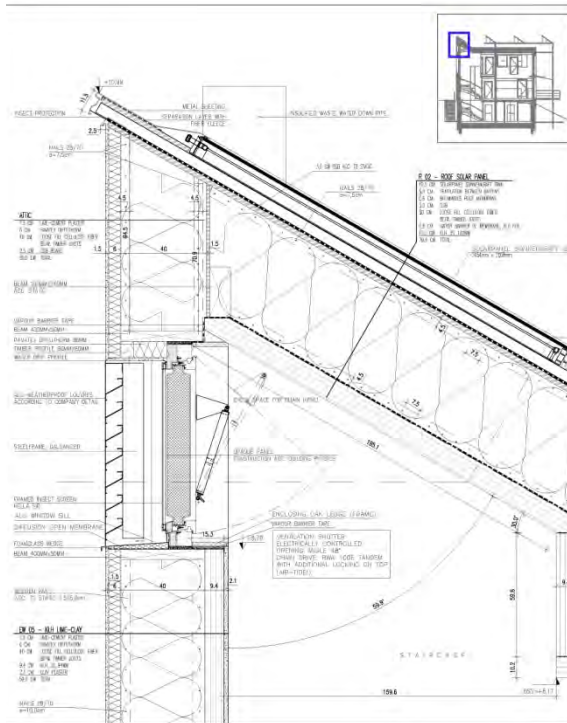












Wall construction

$$U = 0,105 \text{ W/(m}^2\text{K)} \quad \Psi -0,046 \text{ W/(mK)}$$



Thermal bridge calculation

Software:	THERM 6.3
Date:	03.04.2013
Calculations done by:	Kristo Kalbe

PassiveHouse

Exterior wall external corner

U_{1D} 0.0978 W/m²K

l₁ 1998.9 mm

U_{2D} 0.0978 W/m²K

l₂ 2014.1 mm

U_{2D} 0.0822 W/m²K

Respective 4013 mm

length

L_{1D} 0.392 W/mK

L_{2D} 0.330 W/mK

Ψ -0,063 W/mK

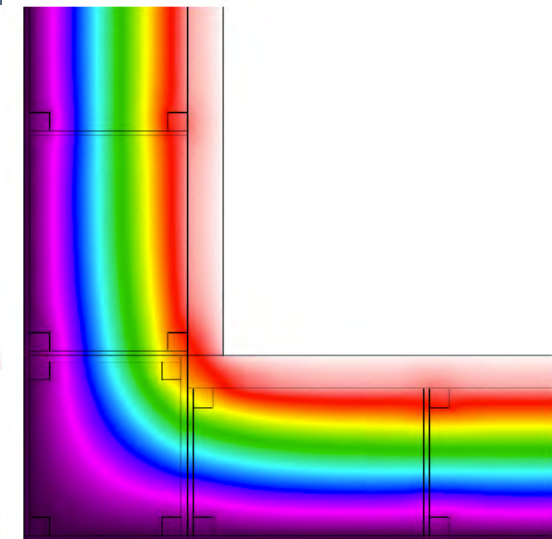
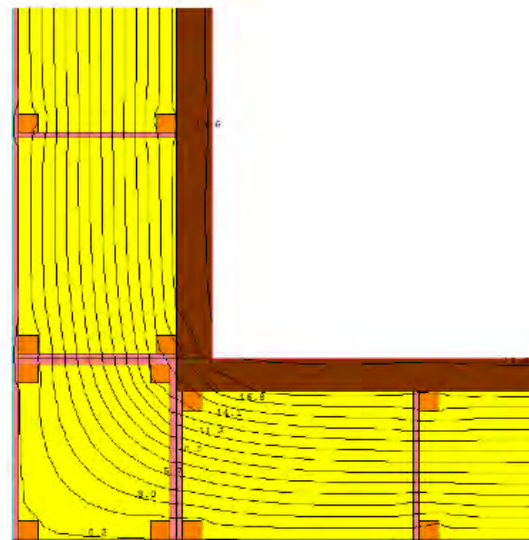
Boundary conditions

	R _s (W/mK)	θ (°C)
Interior	0,13	20,0
Exterior	0,04	-10,0

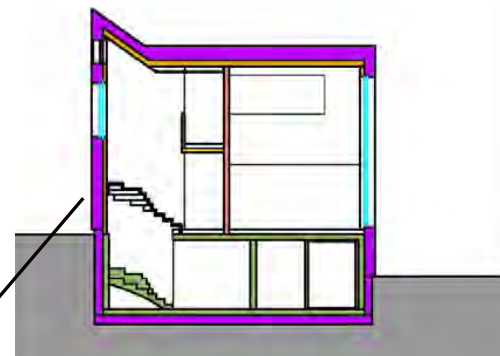
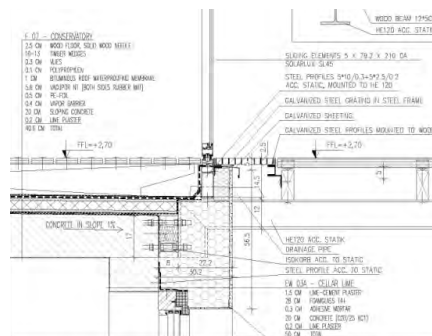


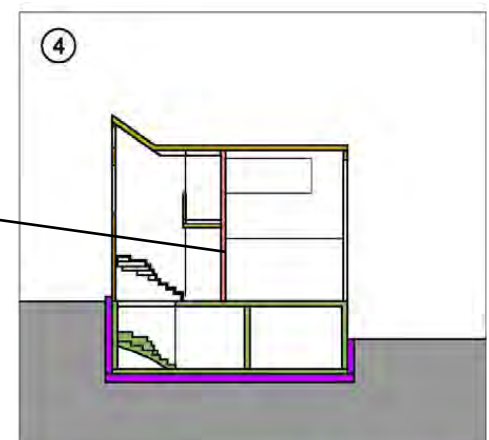
PassiveHouse

Boundary conditions		
	R _s (W/mK)	θ (°C)
Interior	0,13	20,0
Exterior	0,04	-10,0



calculation: PassiveHouse OÜ



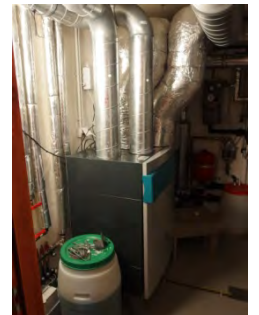
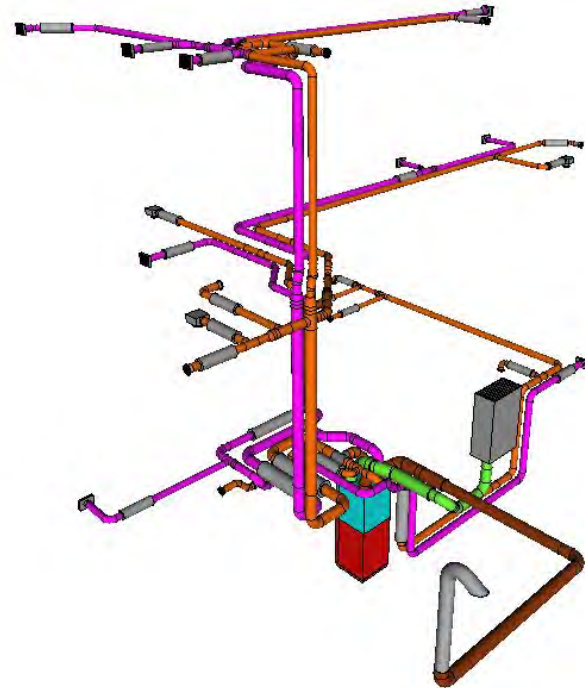


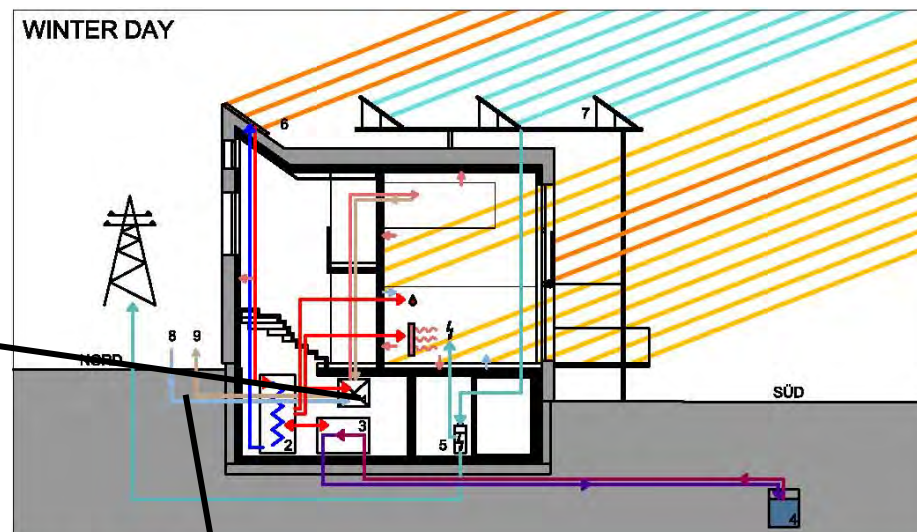




airtightness

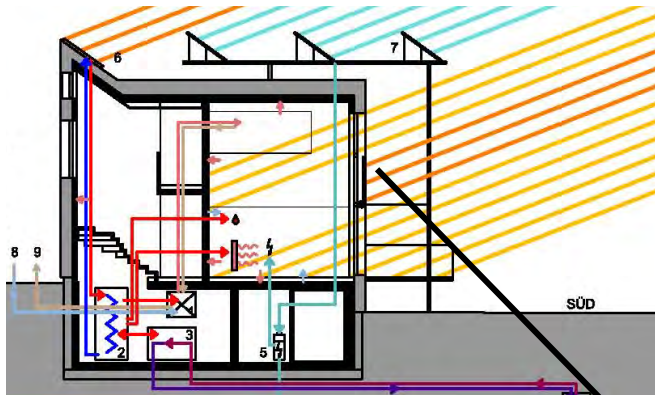
$$n_{50} = 0,31 \text{ h}^{-1}$$



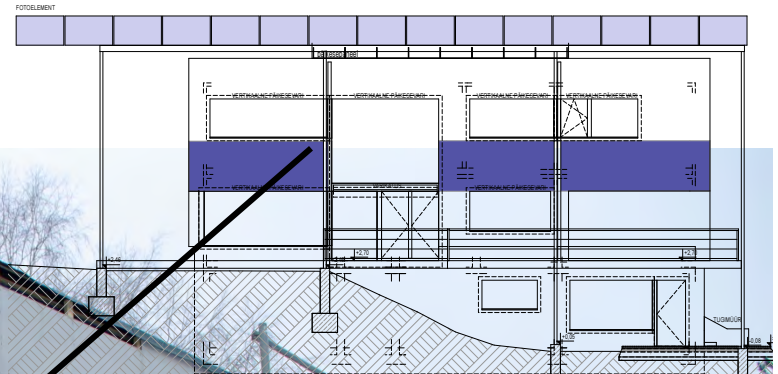


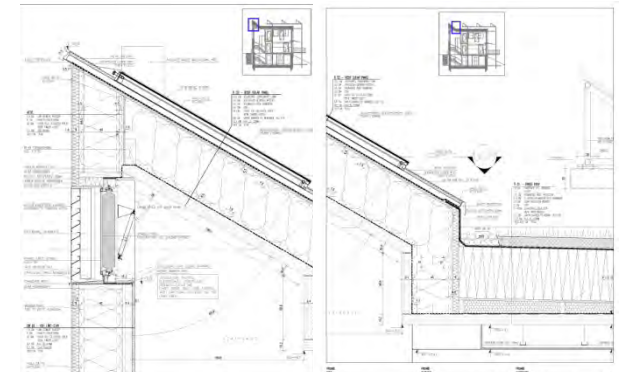
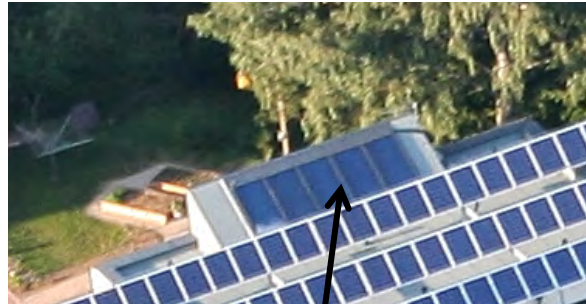
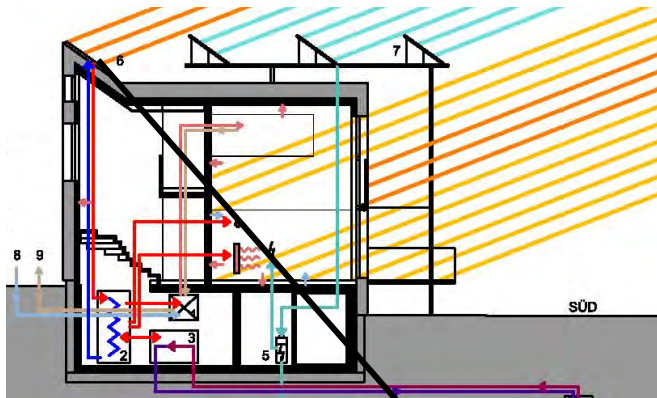
Ventilation unit
 Paul Novus 300 Heat recovery **93%**
 after Passivhaus Institute Darmstadt
 Definition
 Brain loop preheater

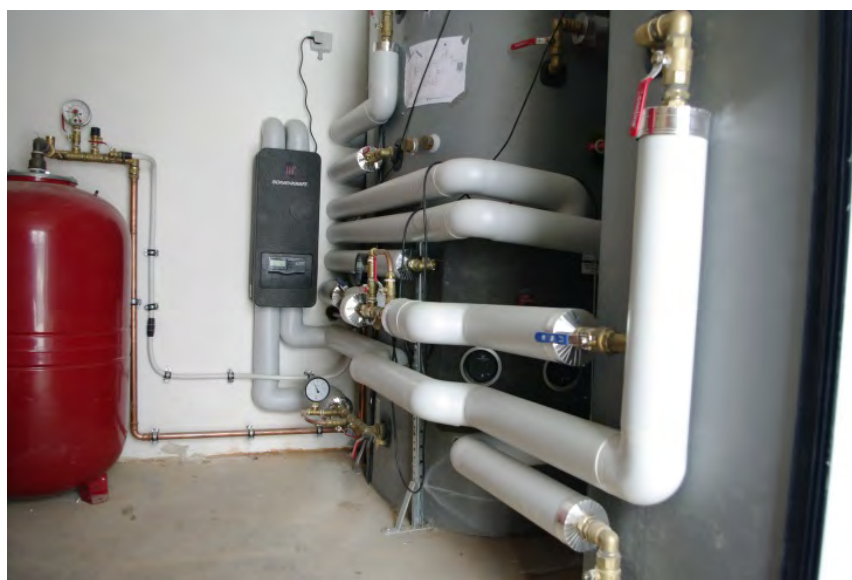




separate array of solar thermal collectors 13 m² for heating and warm water integrated to southern façade and optimized for the winter operation

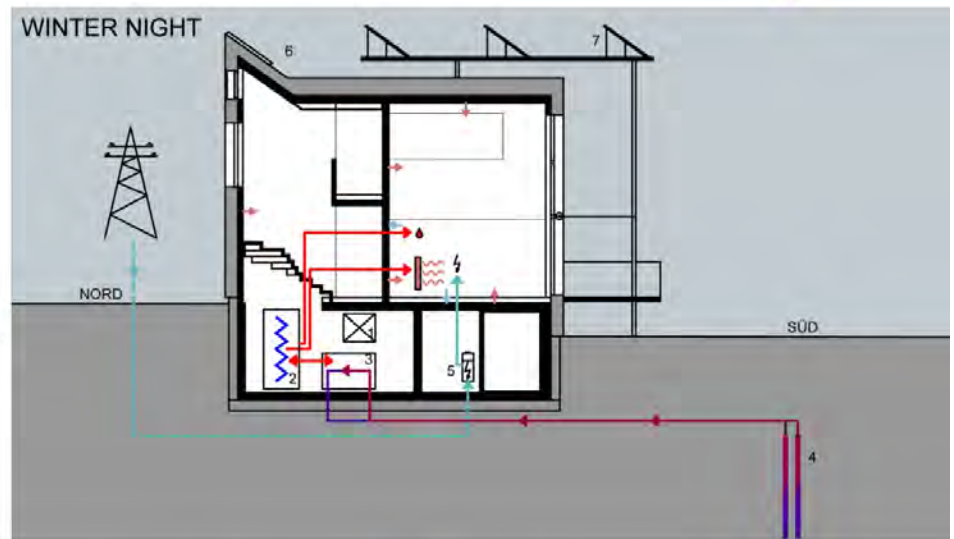
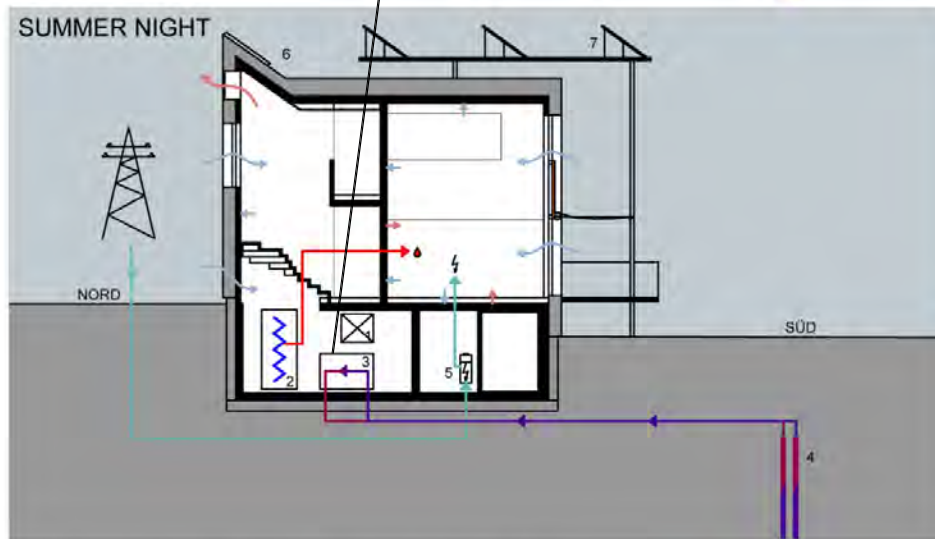


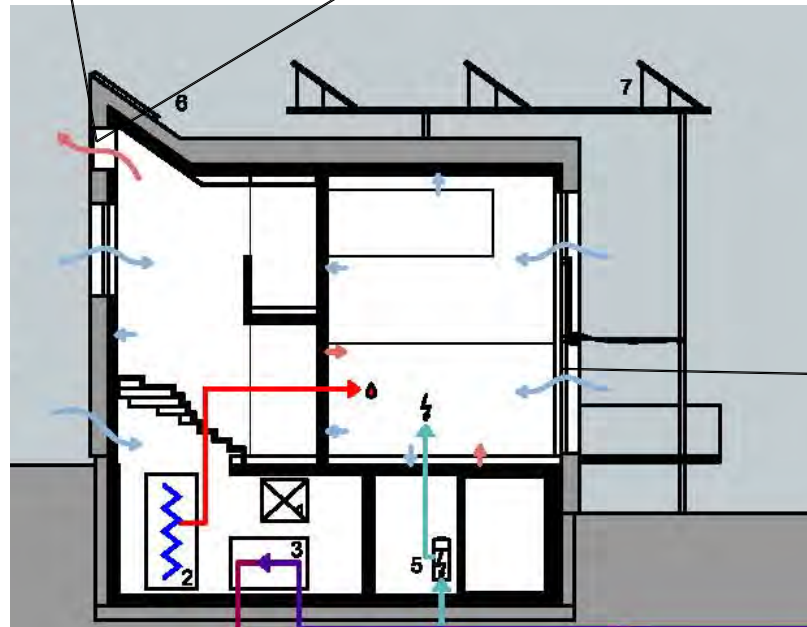




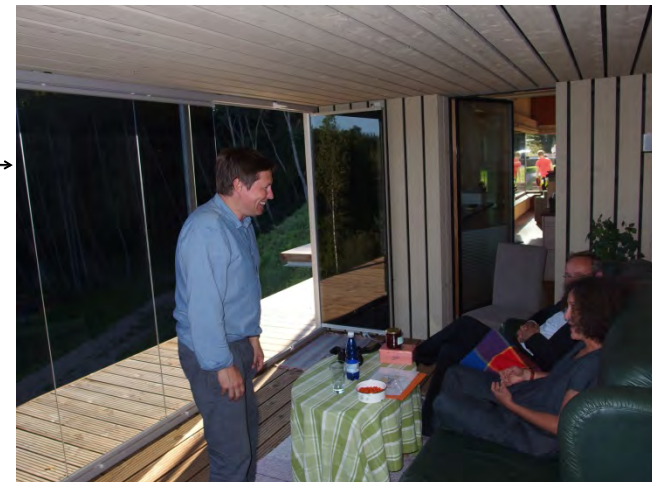
2 x 1000 L

Annual production of the system 4900 kWh





Summer night ventilation

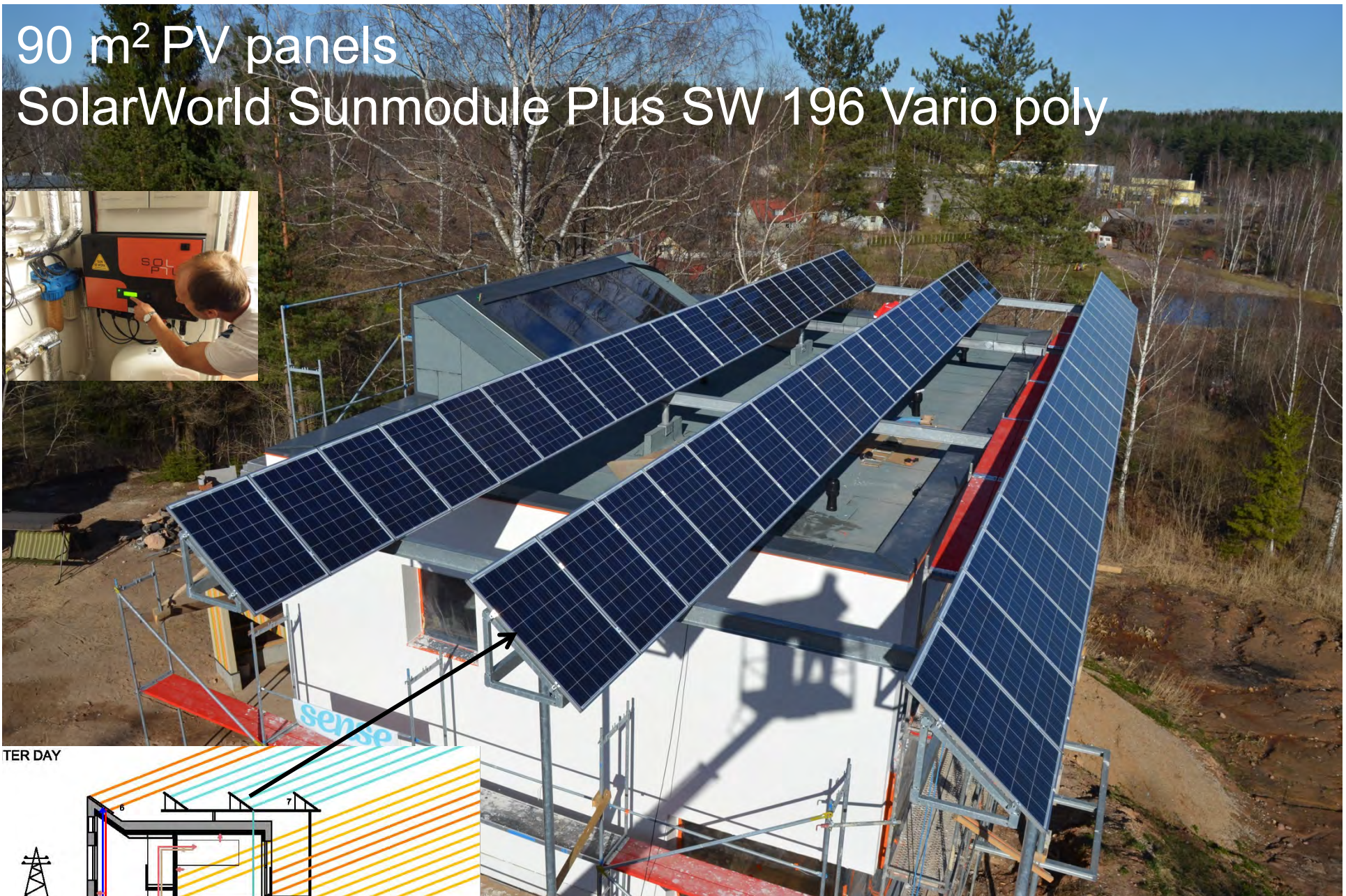




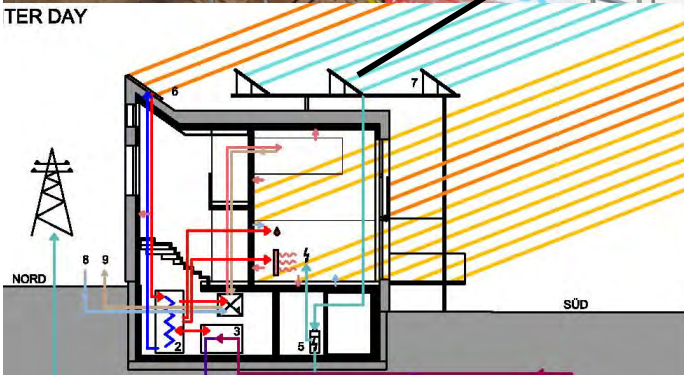




90 m² PV panels
SolarWorld Sunmodule Plus SW 196 Vario poly



TER DAY



Annual production of the system **10120** kWh

3) RESULTS



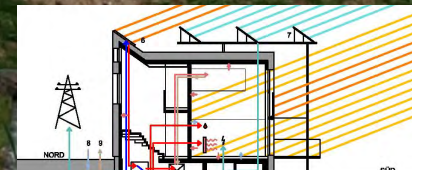






















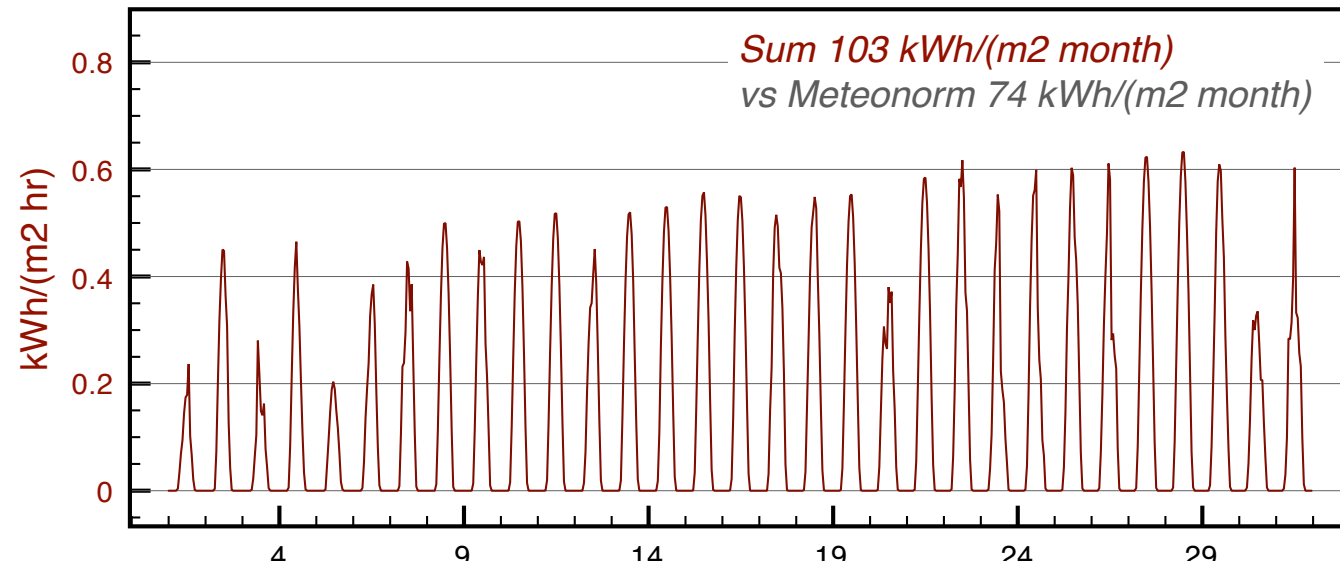




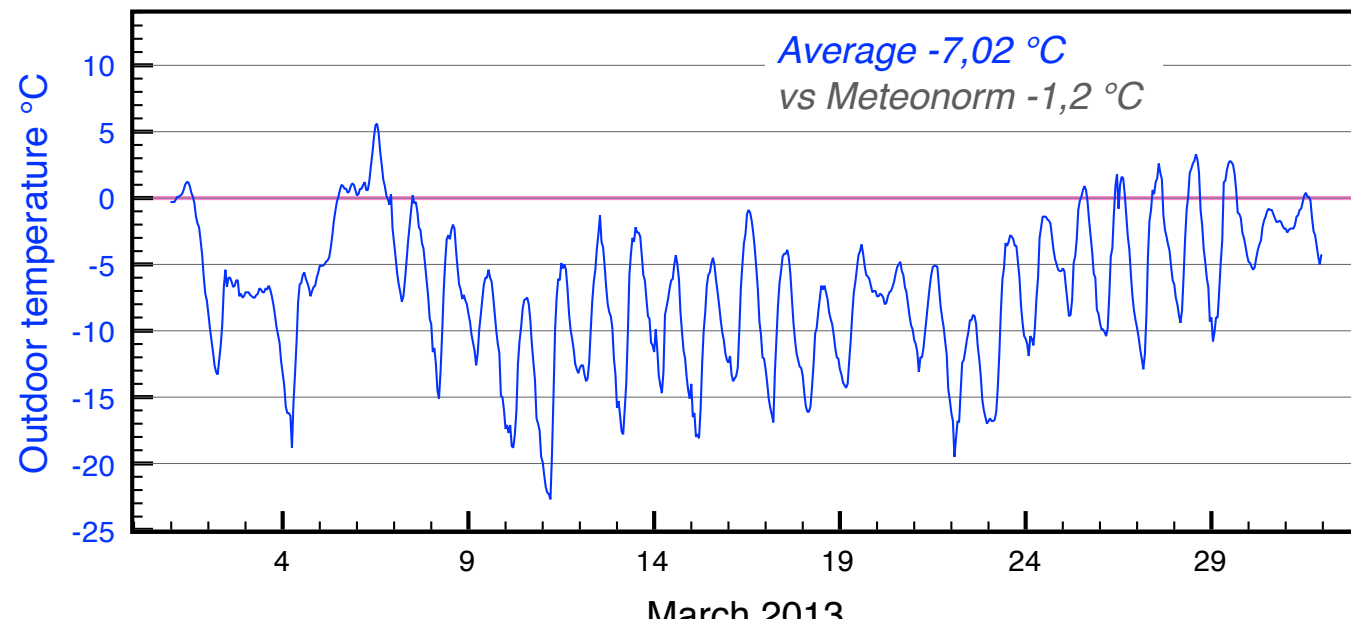


The sunniest March over 44 year period

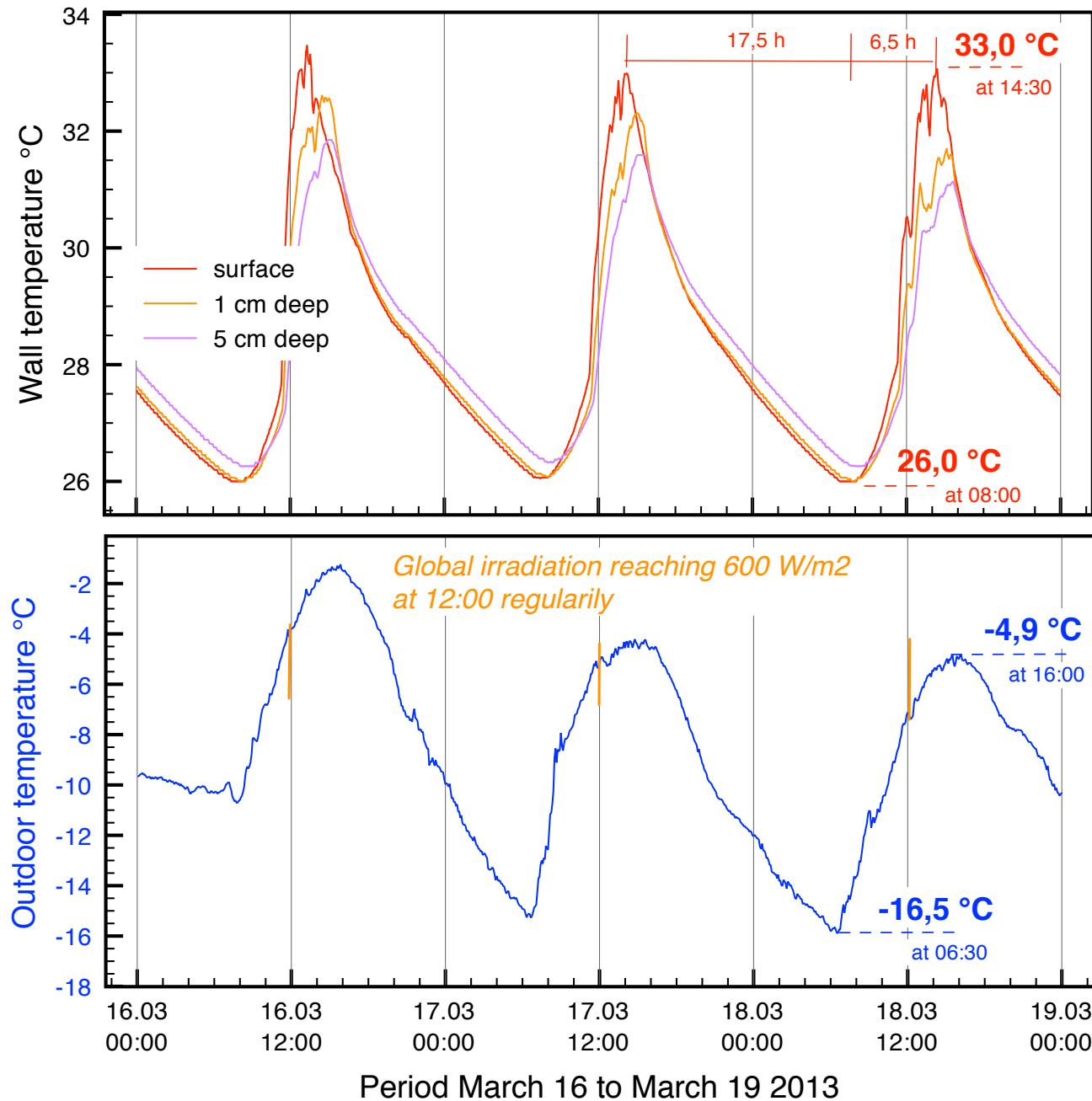
Global radiation, hourly sums, Tartu Tõravere, Estonia



Outdoor dry bulb temperature, hourly values, Tartu Tõravere, Estonia



Massive wall exposed to direct solar beam, temperature course in 3-days period



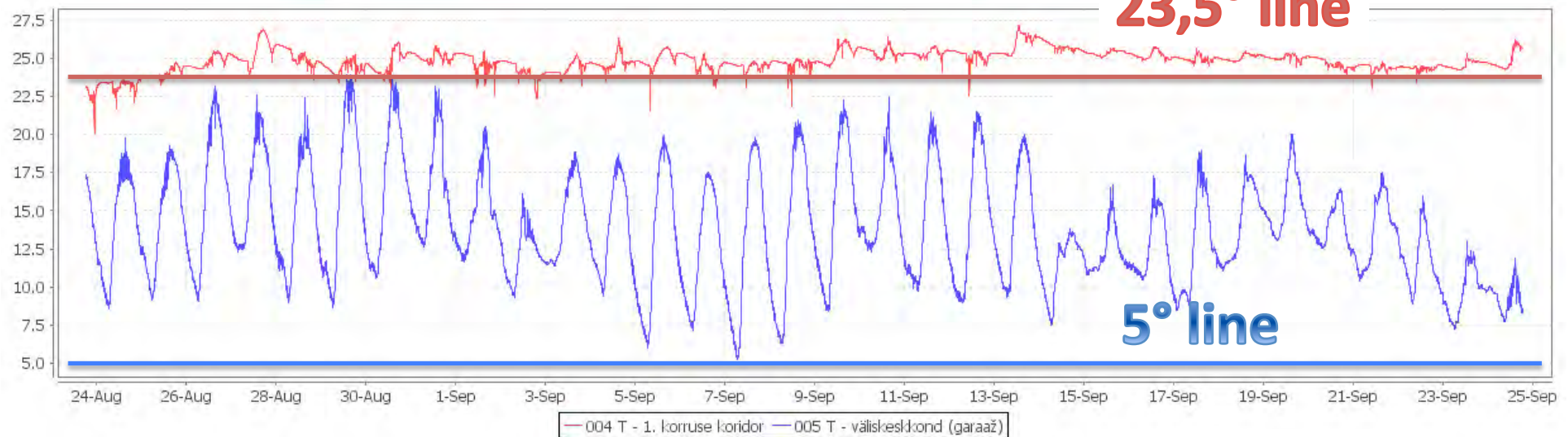
**Heating up
the indoor
massive wall**

**Regular
temperature
increase 7 K
in 6,5 hr**

**No additional
heating in
whole March**

Measured air temperatures

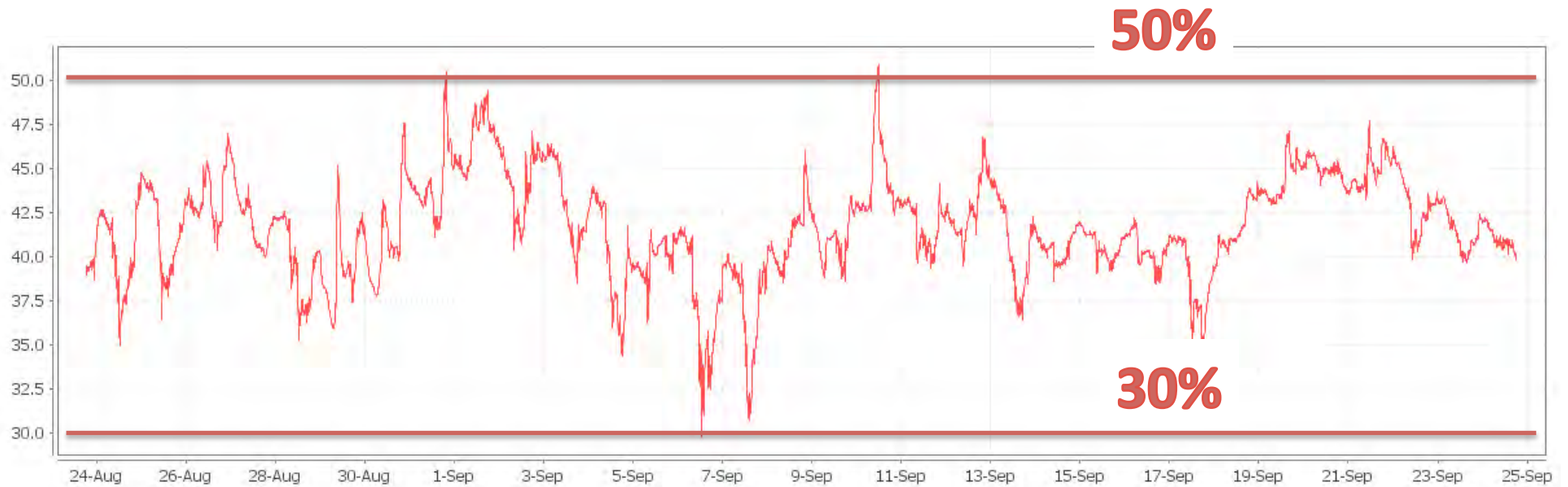
indoor air
23,5° line



outdoor air

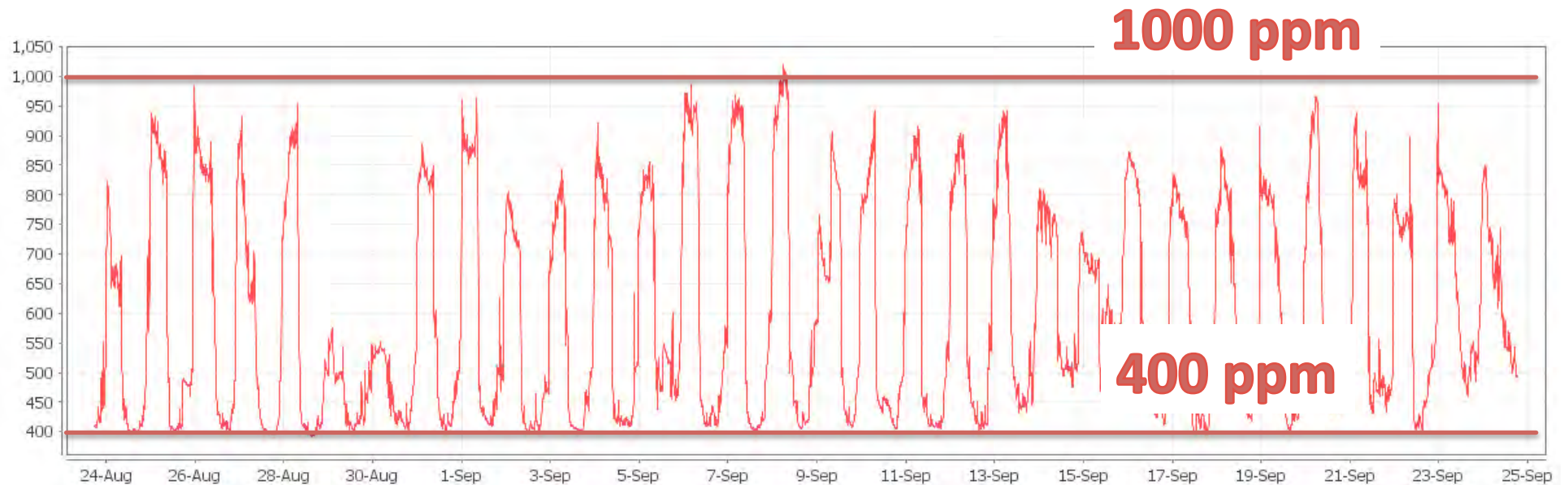
1 month period: Aug 24 to Sept 24 2013

Measured indoor air relative humidity % 1st floor bedroom



1 month period: Aug 24 to Sept 24 2013

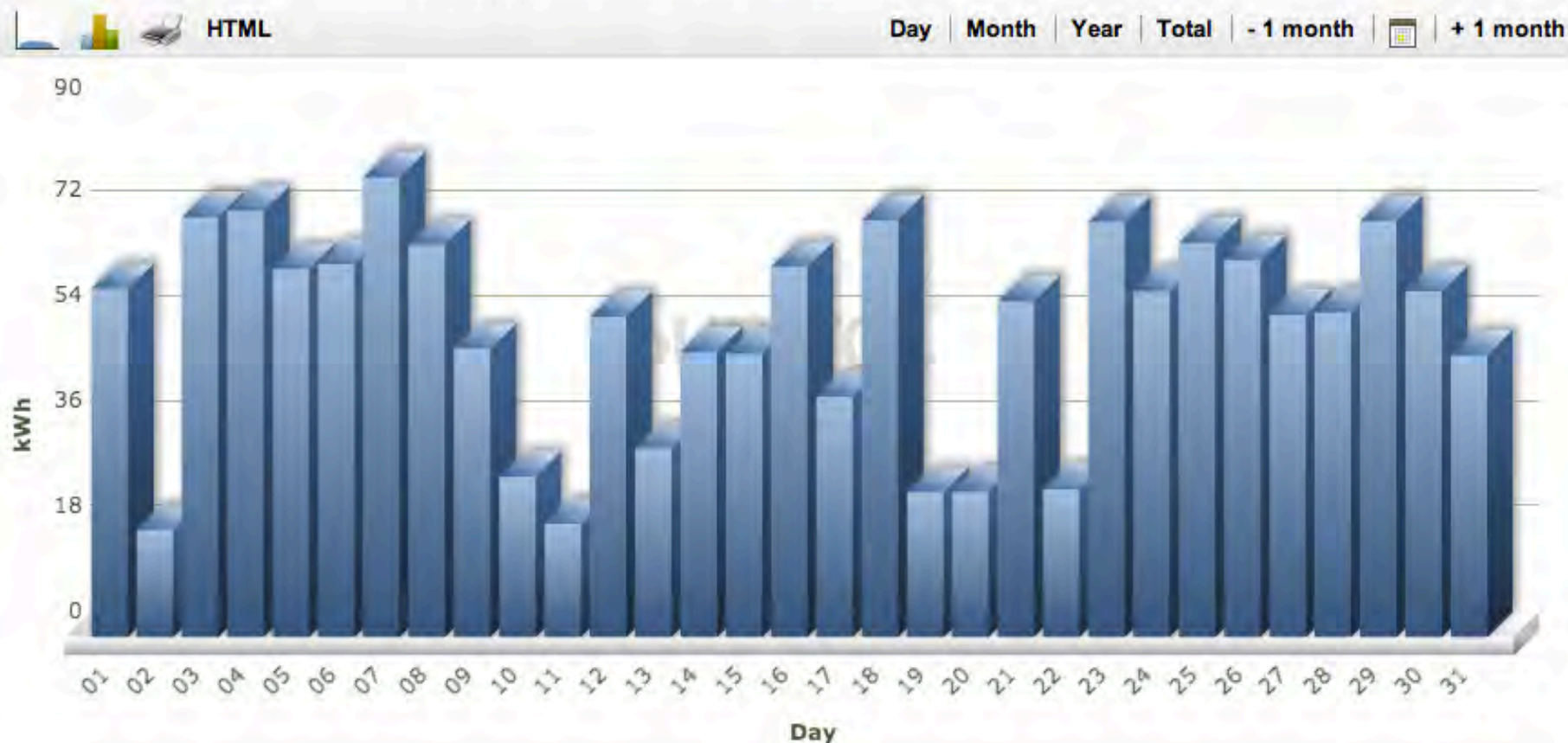
Measured indoor air CO₂ concentration 1st floor bedroom



1 month period: Aug 24 to Sept 24 2013

PV production August 2013

Päikesepaneelid Metsa 5a Põlva - Monthly results August 2013



Output values for a month August 2013

Chart view

Chart type:

Columns 3D

Show

Output:	1,637.54 kWh
Specific output:	126.59 kWh/kWp
CO ₂ saved:	1,148.31 kg
Bought from grid:	483 kWh
Sold to grid:	1283 kWh



Thank you for listening!

www.reinberg.net
tonu.mauring@ut.ee

Questions?