TARTU ÜLIKOOL

Seiretulemused, energiatõhusus

Tõnu Mauring

Uurimisobjektid

Metsa 5a, Põlva

Arh. Georg Reinberg

Kasulik pind	280 m^2
Ehitamise aeg	2012-2013
Ehituse juhtimine	Sense OÜ
Kasutuse algus	veebr 2013

Pihla 2, Tartu

Arh. Eneli Markvart

Kasulik pind	155 m^2
Ehitamise aeg	2013
Ehituse juhtimine	Sense OÜ
Kasutuse algus	dets 2013

Tulemused

Metsa 5a, Põlva

Ostetud energia, aasta
Elekter 10663 kWh

Müüdud energia, aasta
Elekter 9619 kWh

Neto ost 1044 kWh
3,7 kWh/m^2
309 € 1,1 €/m^2

Pihla 2, Tartu

Ostetud energia, aasta
Elekter 3765 kWh
Gaas 423 m^3 = 3934 kWh
Kokku 7699 kWh
51 kWh/m^2

Elekter 436 €
Gaas 250 €
Kokku 686 € 4,6 €/m^2

Projekt

Primary Energy Factors and CO_2-Equivalent Emissions Factors of Various Energy Carriers

Energy Carrier	Primary Energy (non-regenerative) kWh_{Prim}/kWh_{Final}	CO_2 GEMIS 3.0 kg/kWh_{Final}
Oil	1.1	0.31
Natural Gas	1.1	**0.25**
Wood	0.2	0.05
Electricity-Mix	2.6	**0.68**
Electricity from PV	0.7	0.25

Tulemused

Metsa 5a, Põlva

Emissioon aasta jooksul:
Elekter 708 kg/CO_2

per m^2 2,5 kg/CO_2

Pihla 2, Tartu

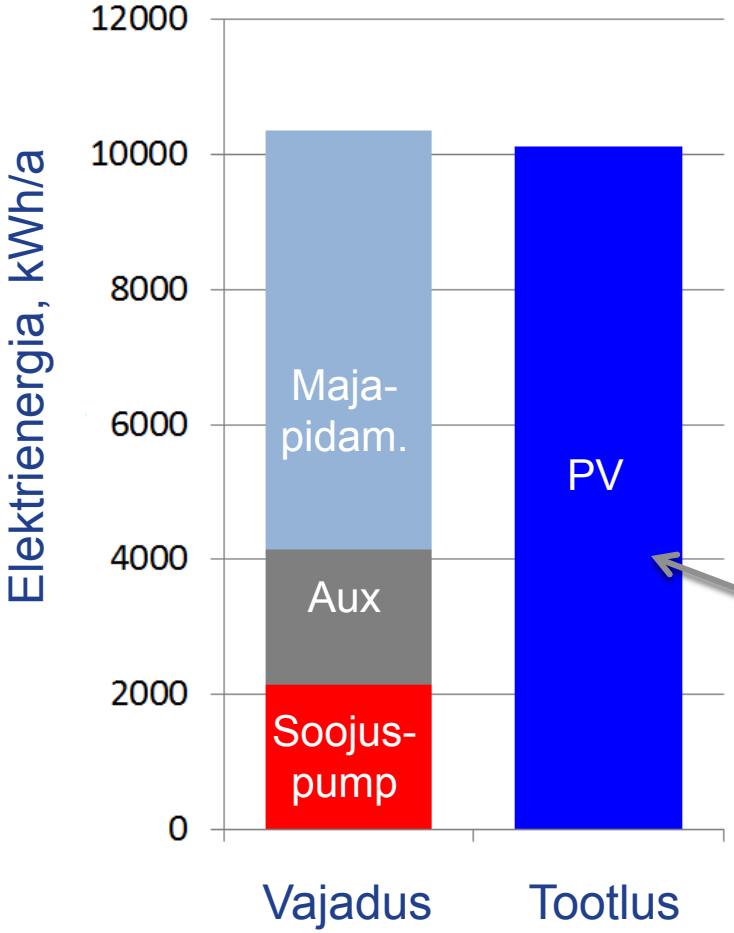
Emissioon aasta jooksul:
Elekter 2560 kg/CO_2
Gaas 984 kg/CO_2
Kokku 3544 kg/CO_2

per m^2 23,6 kg/CO_2

Metsa 5a, Põlva

Lõppenergia

Arvutuslik



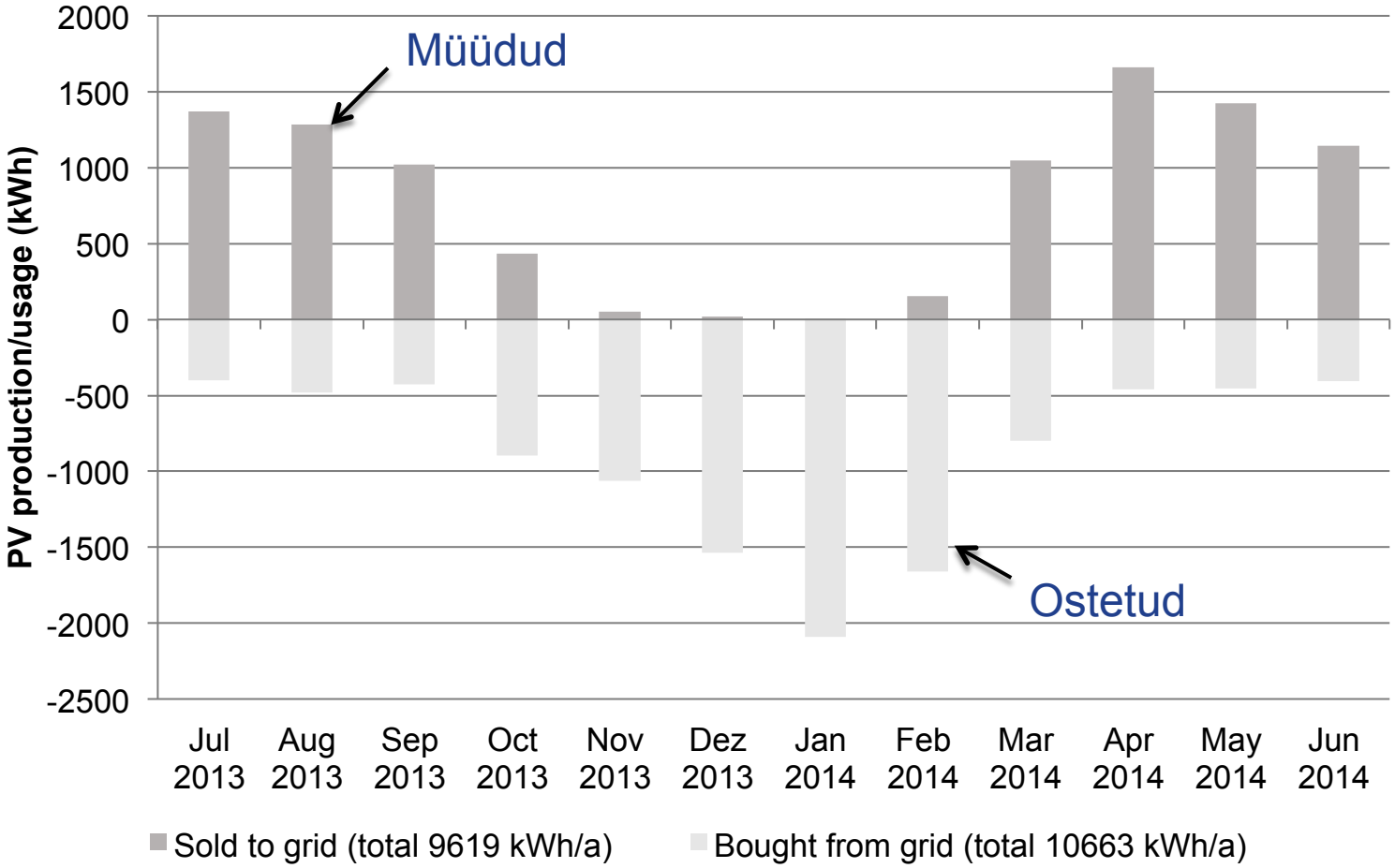
Elektrienergia vajadus:
kõik kokku:
10 360 kWh

PV tootlus
10 120 kWh/a

Neto vajadus ≈ 0

Metsa 5a, Põlva

Mõõdetud PV



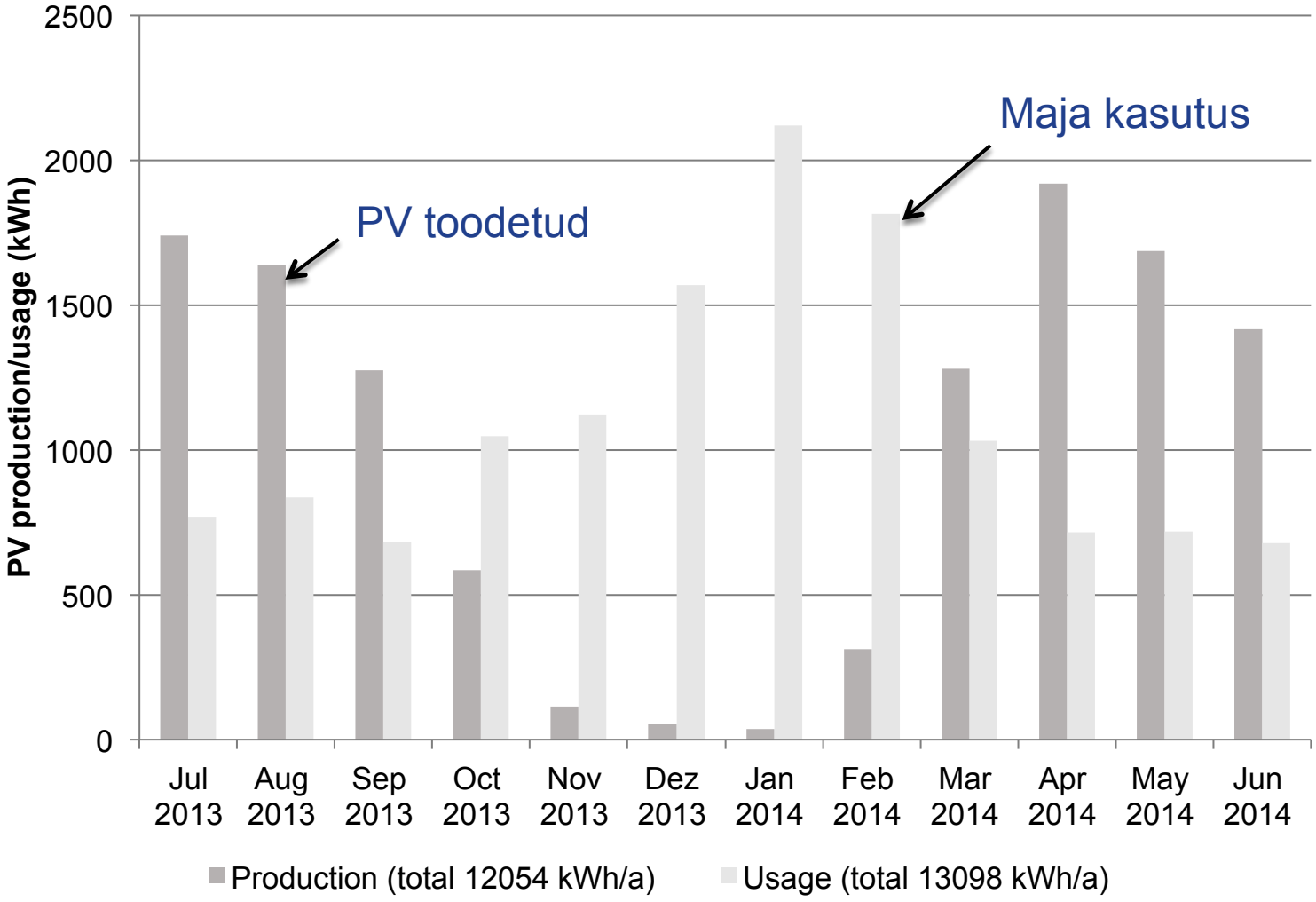
Metsa 5a, Põlva

Mõõdetud PV

	Müüdud **kWh**	Ostetud **kWh**
Juul 2013	1369	398
Aug 2013	1283	482
Sep 2013	1022	428
Okt 2013	434	895
Nov 2013	54	1062
Det 2013	20	1535
Jaan 2014	4	2087
Veeb 2014	155	1657
Mär 2014	1049	800
Apr 2014	1660	458
Mai 2014	1424	455
Juun 2014	1145	406
Aasta kokku	**9619**	**10663**

Metsa 5a, Põlva

Mõõdetud PV



Metsa 5a, Põlva

Mõõdetud PV

http://www.suntrol-portal.com/en/page/paikesepaneelid-polva

	PV toodetud **kWh**	Maja kasutus **kWh**
Juul 2013	1739	768
Aug 2013	1637	836
Sep 2013	1274	680
Okt 2013	585	1046
Nov 2013	114	1122
Det 2013	55	1570
Jaan 2014	36	2119
Veeb 2014	312	1814
Mär 2014	1280	1031
Apr 2014	1918	716
Mai 2014	1687	718
Juun 2014	1417	678
Aasta kokku	**12054**	**13098**

= 46,8 kWh/m^2

kasutusest 3300 kWh on saun

Metsa 5a, Põlva

Mõõdetud PV

	PV toodetud **kWh**	Maja kasutus **kWh**	Ost **€**	Müük **€**
III Q 2013	4650	2284	377	184
IV Q 2013	754	3738	148	485
Kokku	**5404**	**6022**	**525**	**669**
I Q 2014	1628	4964	123	584
II Q 2014	5022	2112	460	164
Kokku	**6650**	**7076**	**583**	**748**
Aasta	**12054**	**13098**	**1108**	**1417**

Maja kasutus = (PV toodetud - Müüdud) + Ostetud

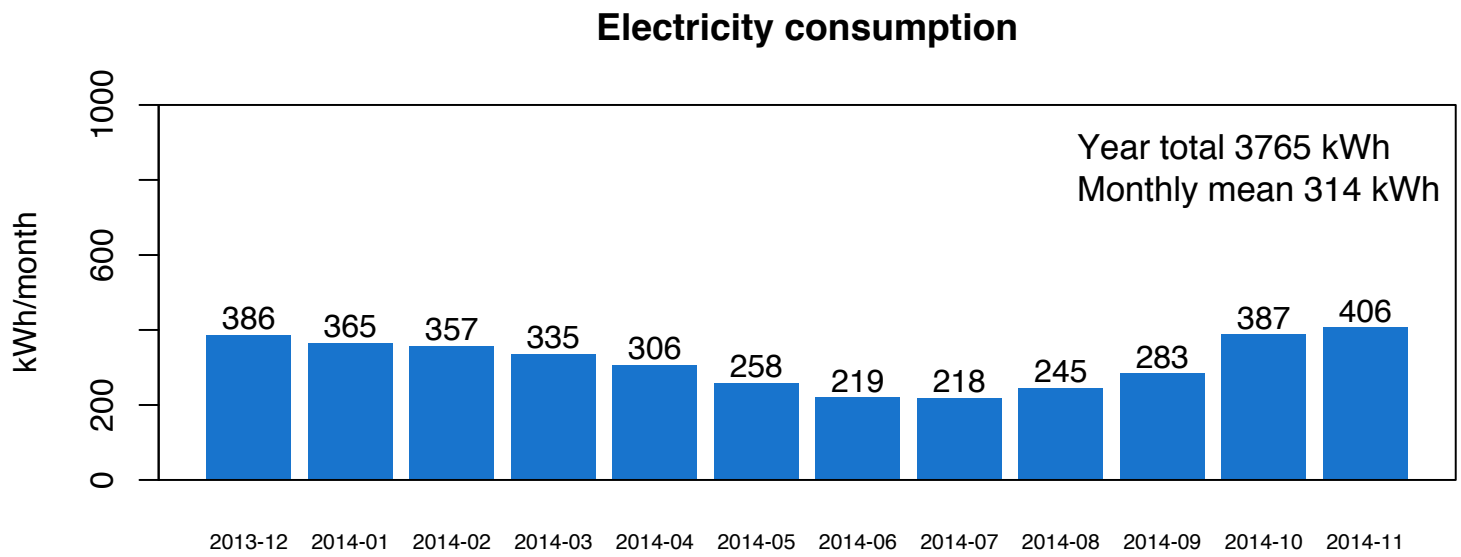
tunnisammuga lugemid

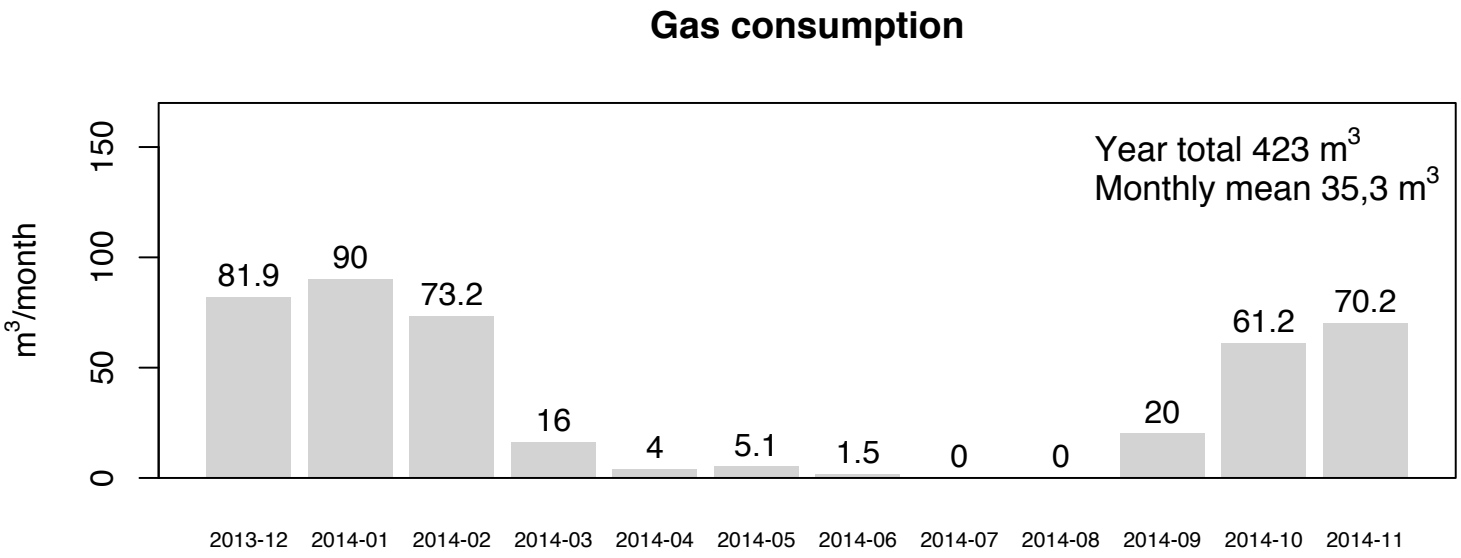
Pihla 2, Tartu

Specific building demands with reference to the treated floor area				use: Monthly method	
	Treated floor area	148.8	m²	Requirements	Fulfilled?*
Space heating	Annual heating demand	**15**	**kWh/(m²a)**	15 kWh/(m²a)	**yes**
	Heating load	**12**	**W/m²**	10 W/m²	-
Space cooling	Overall specific space cooling demand		**kWh/(m²a)**	-	-
	Cooling load		**W/m²**	-	-
	Frequency of overheating (> 25 °C)	6.1	%	-	-
Primary Energy	Space heating and cooling, dehumidification, household electricity.		**kWh/(m²a)**	120 kWh/(m²a)	
	DHW, space heating and auxiliary electricity		kWh/(m²a)	-	-
	Specific primary energy reduction through solar electricity		kWh/(m²a)	-	-
Airtightness	Pressurization test result n_{50}	**0.3**	**1/h**	0.6 1/h	**yes**

Pihla 2, Tartu

Pihla 2, Tartu





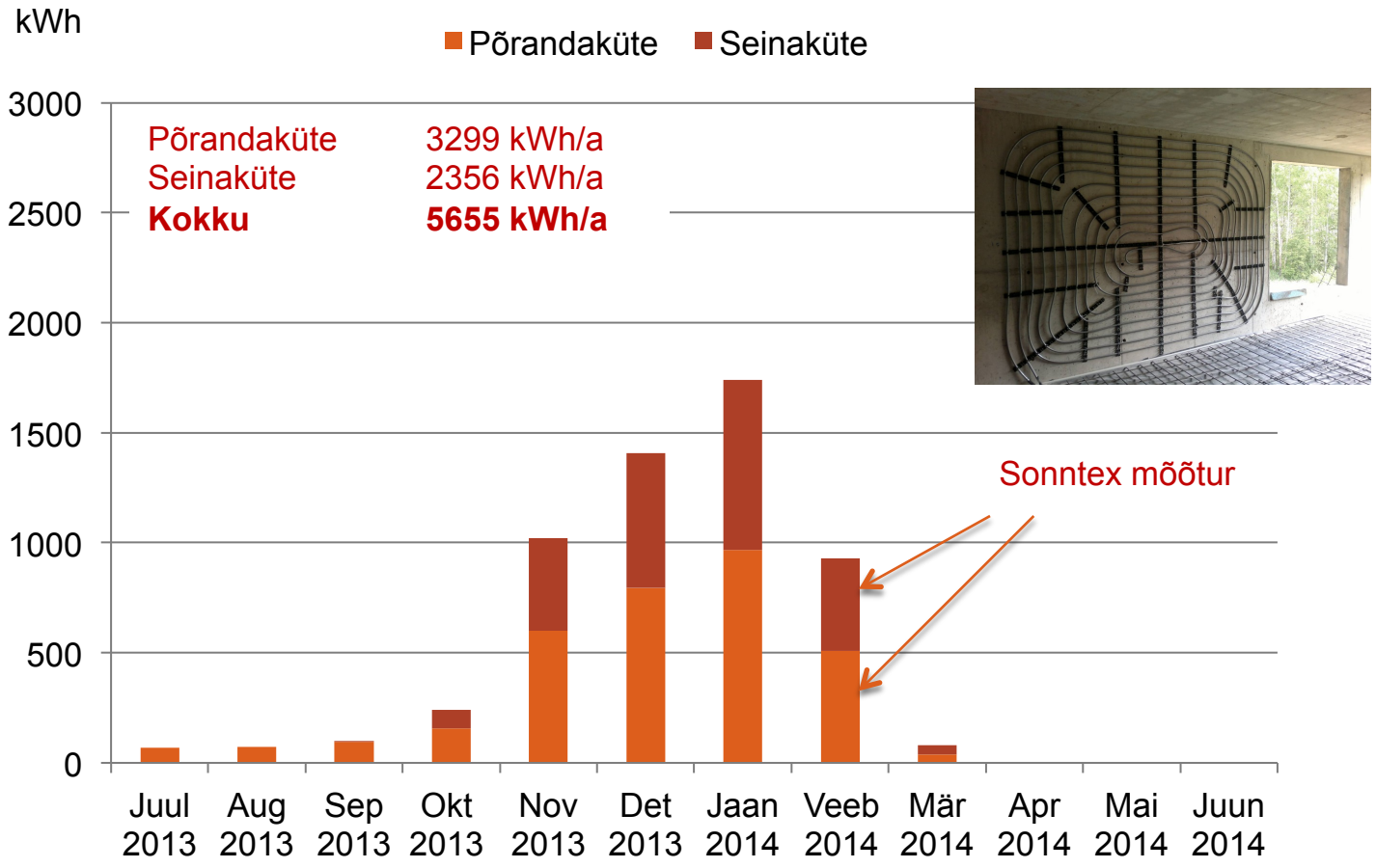
Metsa 5a, Põlva

Seire, küte

Aasta: 5655 kWh

20,2 kWh/m^2 @ ruumitemp 24ºC

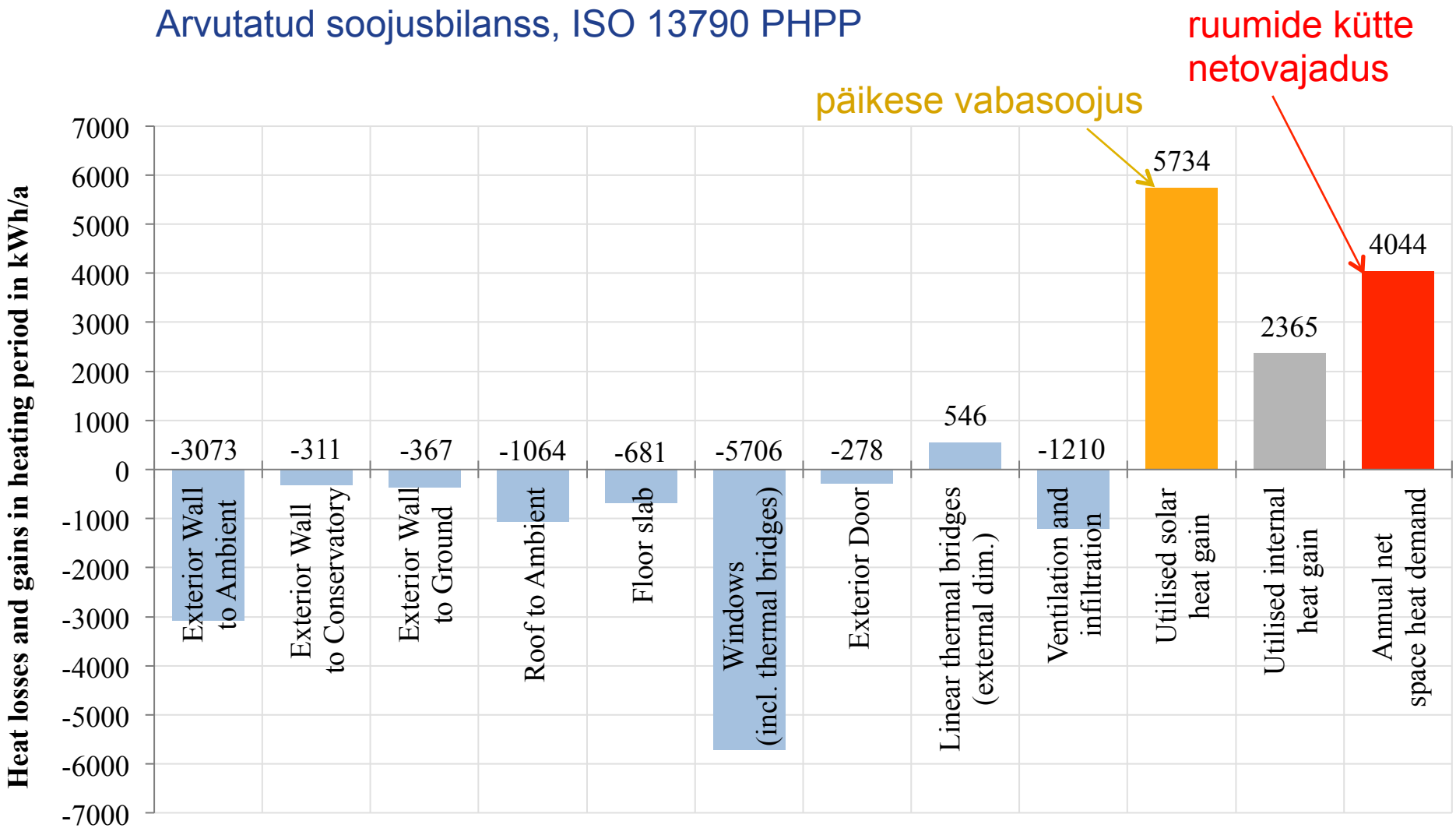
14,4 kWh/m^2 @ ruumitemp 20ºC



Metsa 5a, Põlva

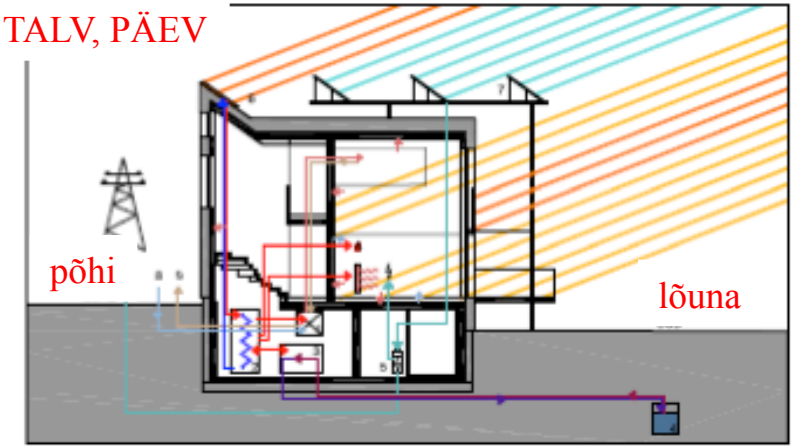
Energiakontseptsioon

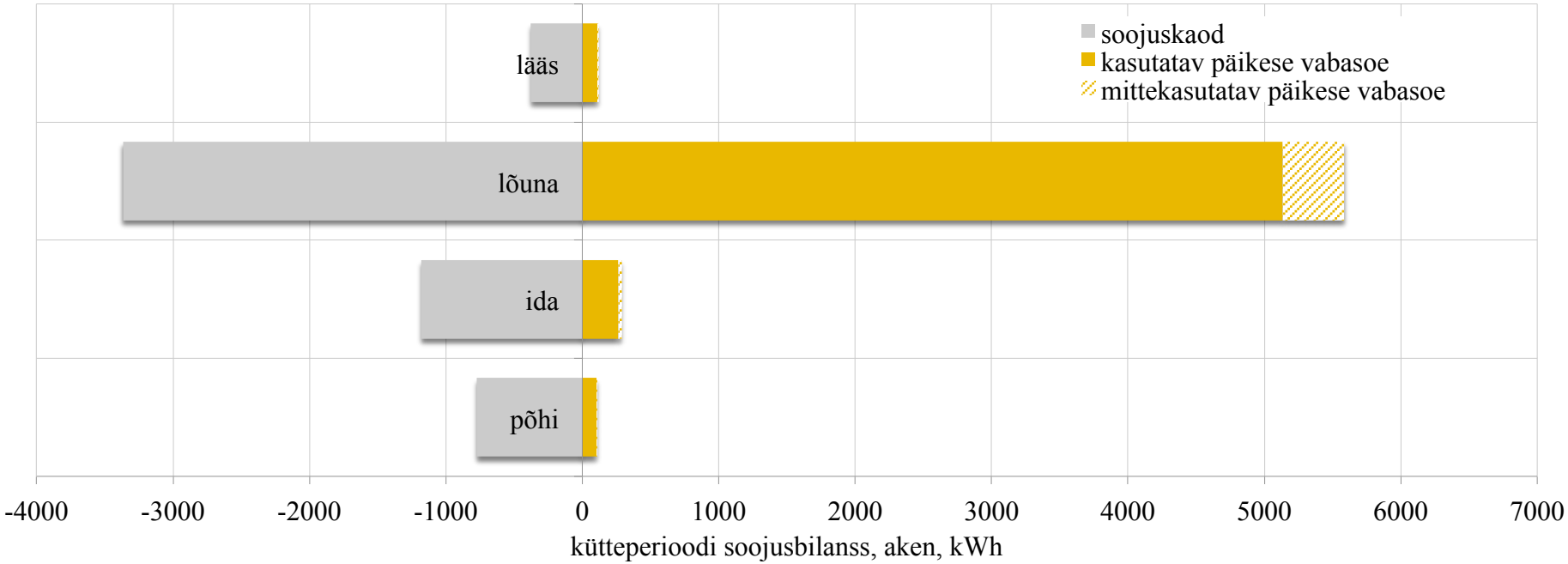
Arvutatud soojusbilanss, ISO 13790 PHPP



Metsa 5a, Põlva

Energiakontseptsioon





Metsa 5a, Põlva

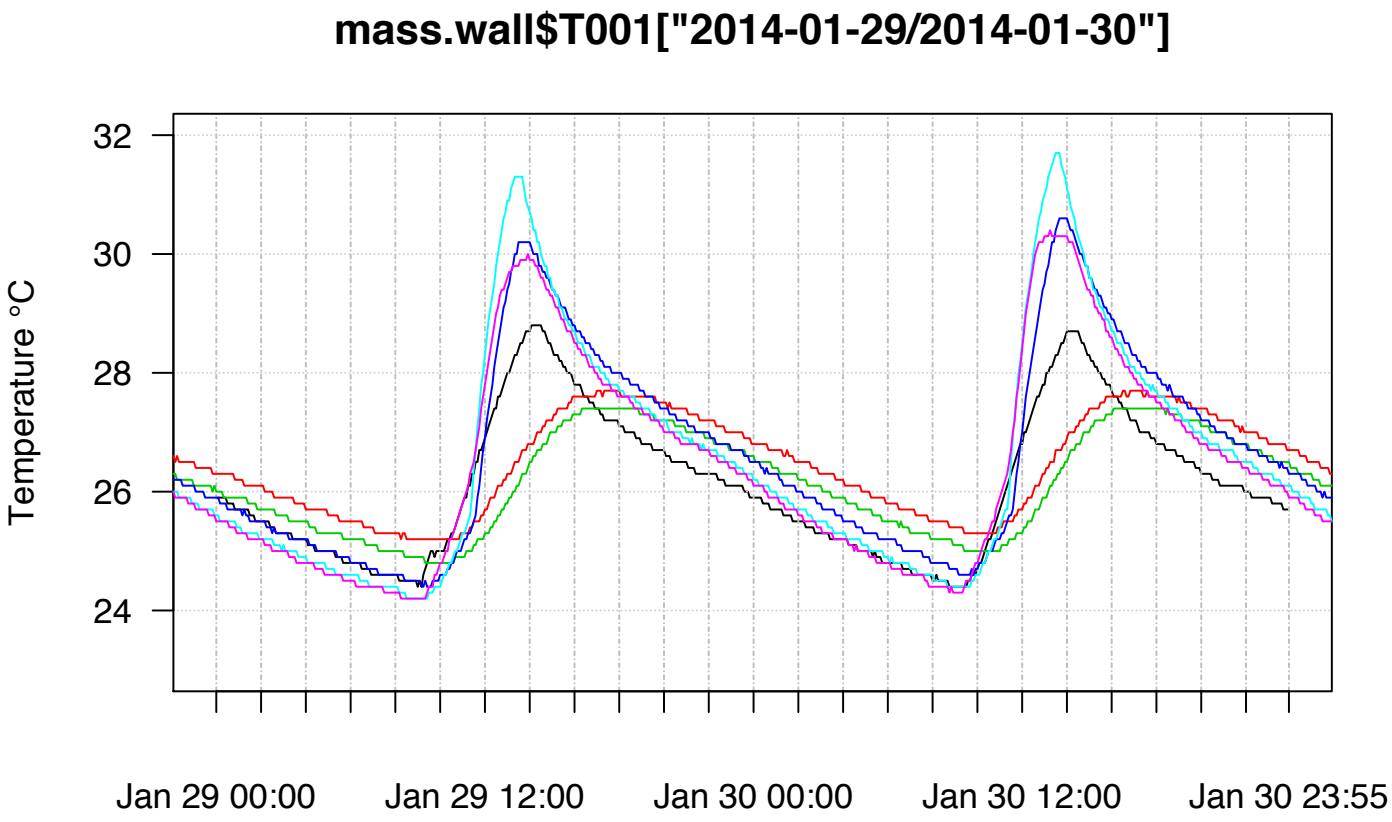
Seire

22 cm massiivsavisein

Metsa 5a, Põlva

Seire

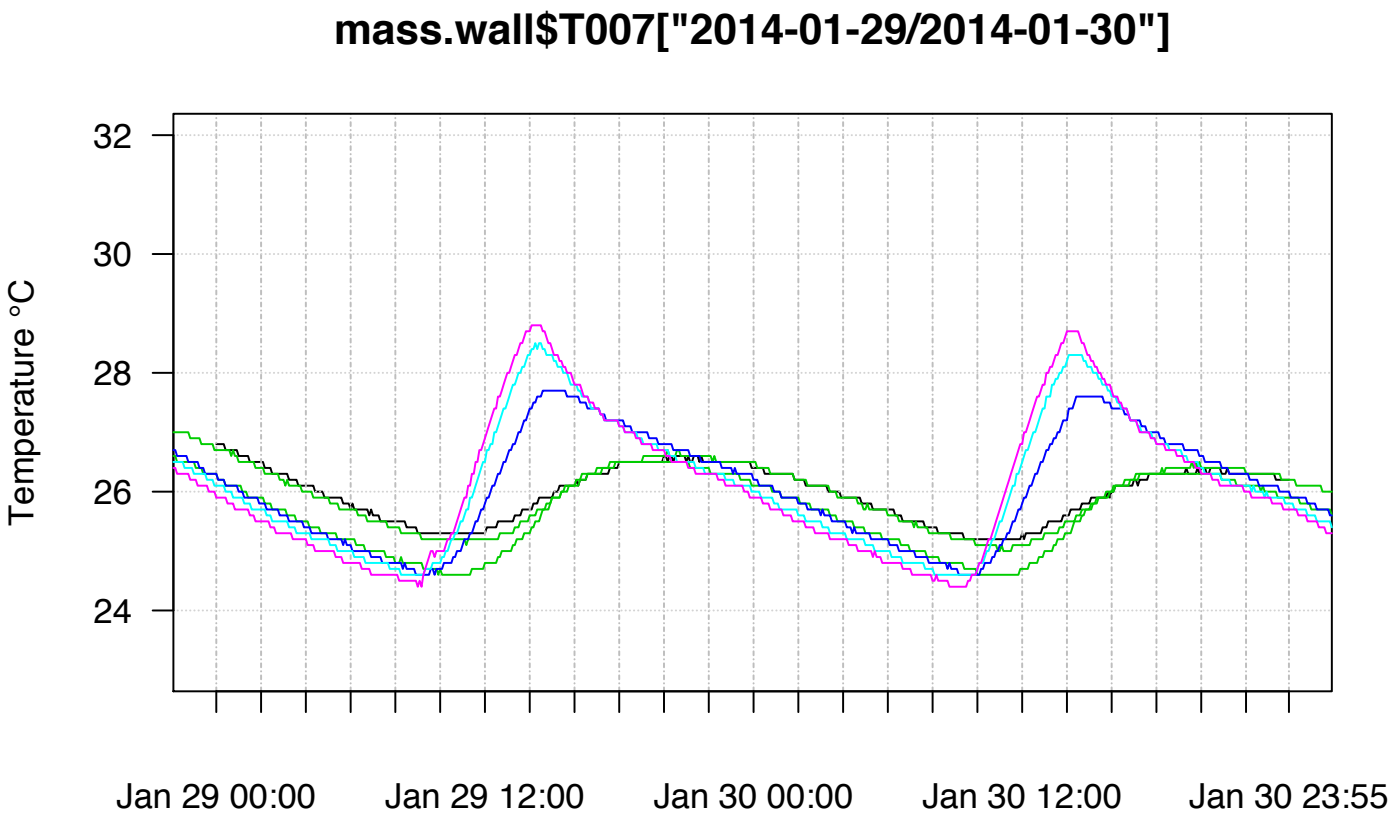
Siseseina temperatuurid, alumine mõõtepunkt



Metsa 5a, Põlva

Seire

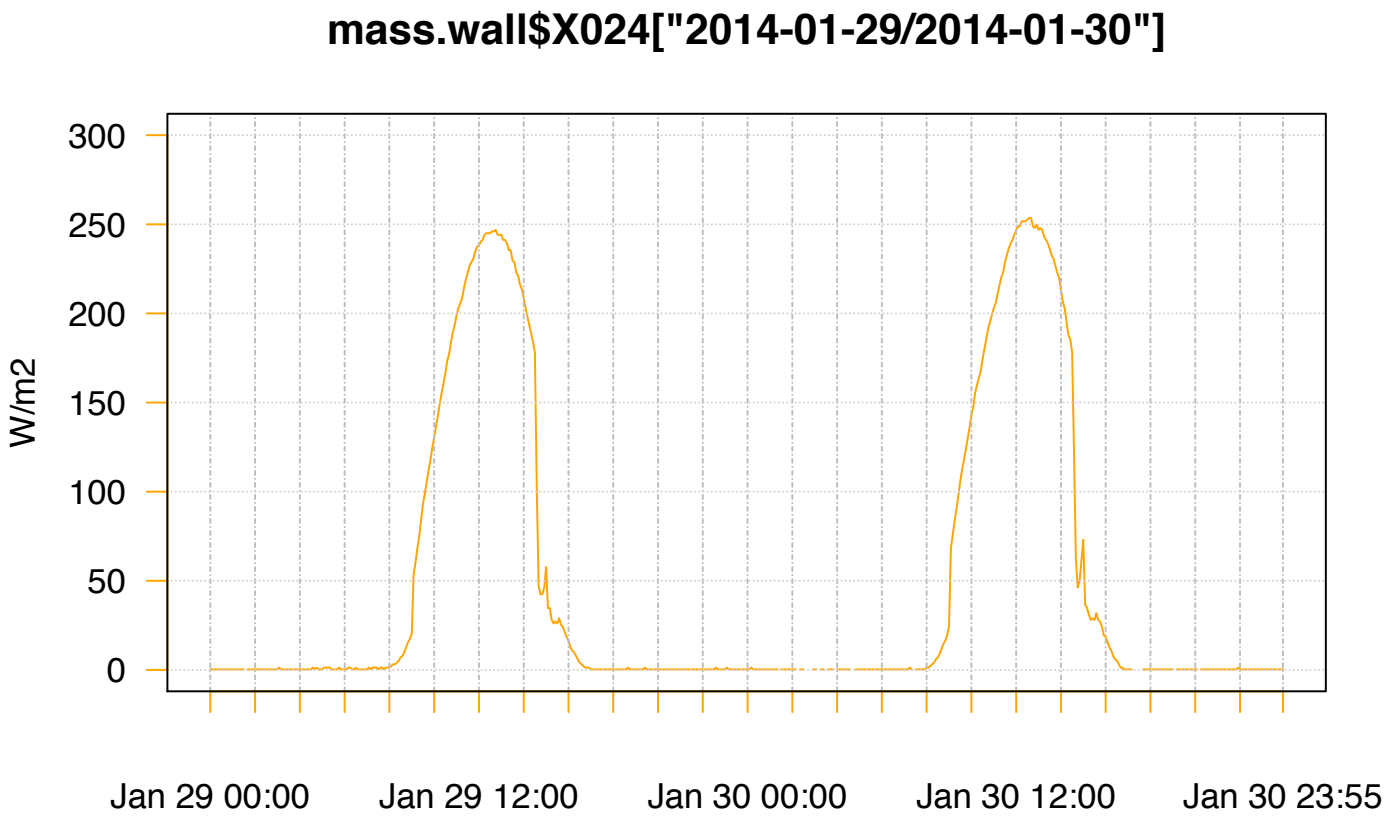
Siseseina temperatuurid, ülemine mõõtepunkt



Metsa 5a, Põlva

Seire

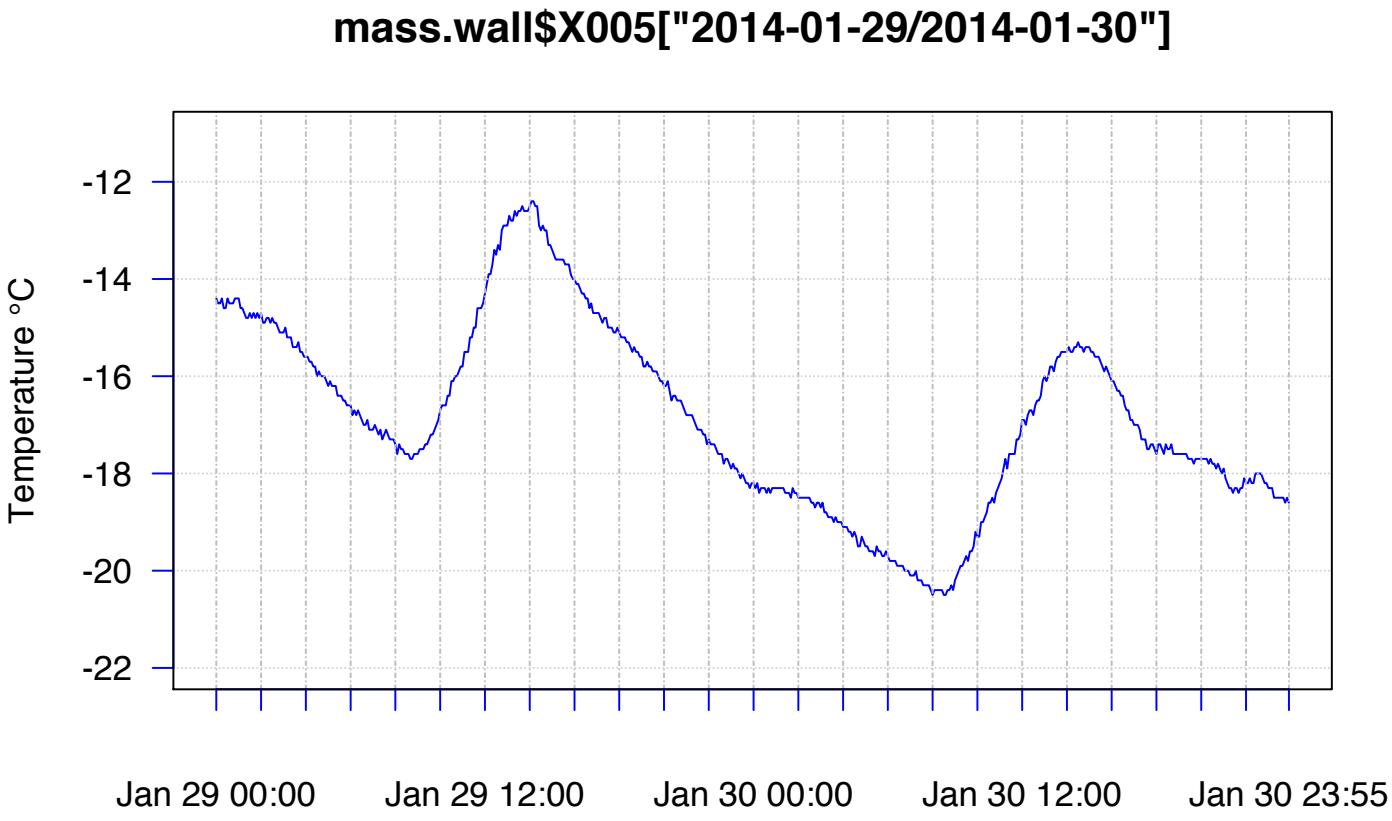
Kiirgus horisontaaltasapinnale (mõõtepunkt hoone katusel)



Metsa 5a, Põlva

Seire

Välisõhu temperatuur

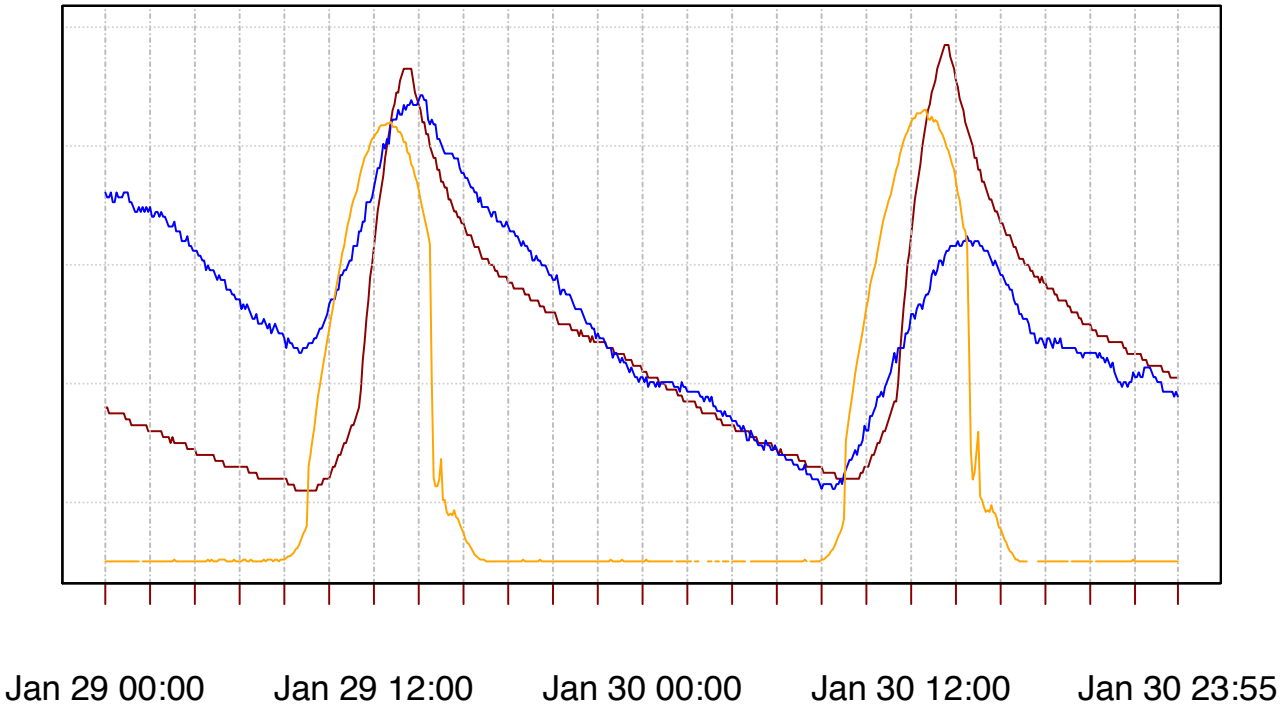


Metsa 5a, Põlva

Seire

Siseseina temperatuur, välisõhu temperatuur, kiirgus

mass.wall$T005["2014-01-29/2014-01-30"]



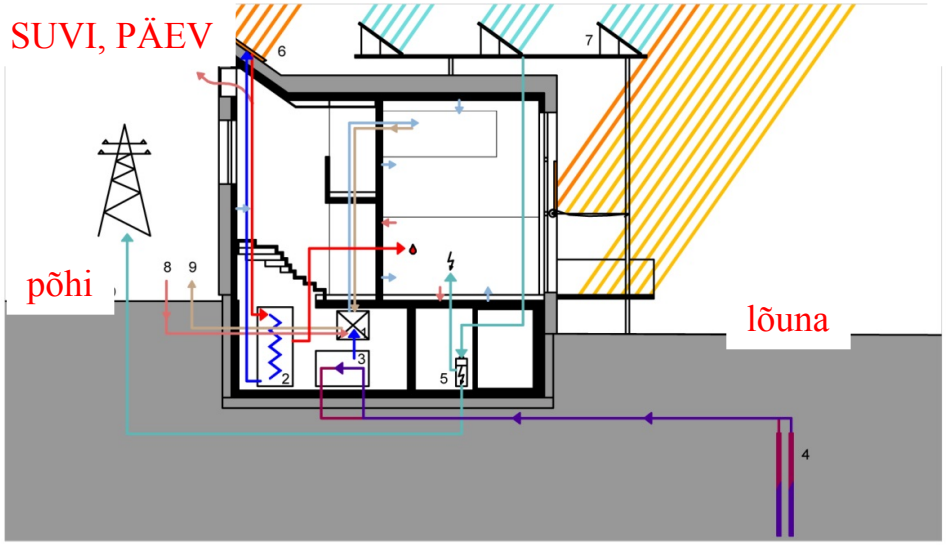
Metsa 5a, Põlva

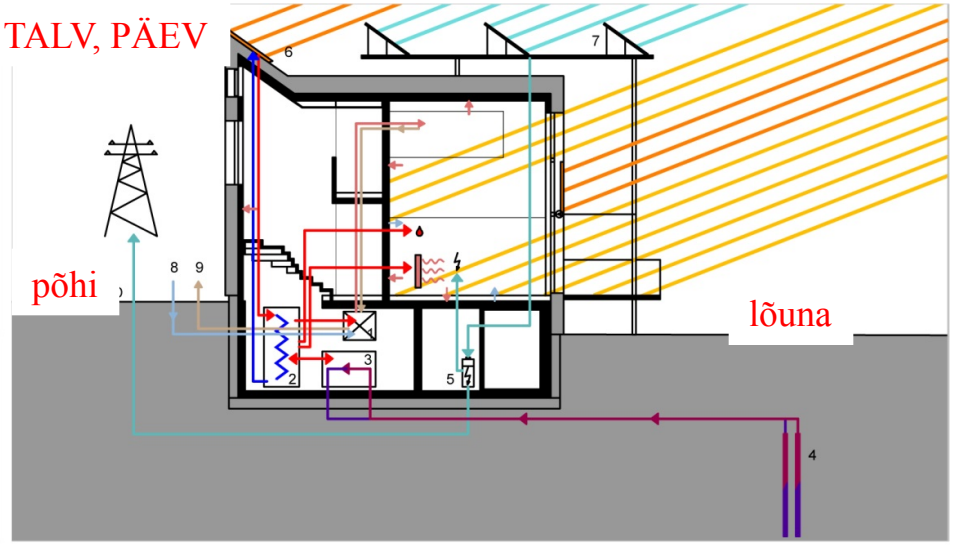
Seire

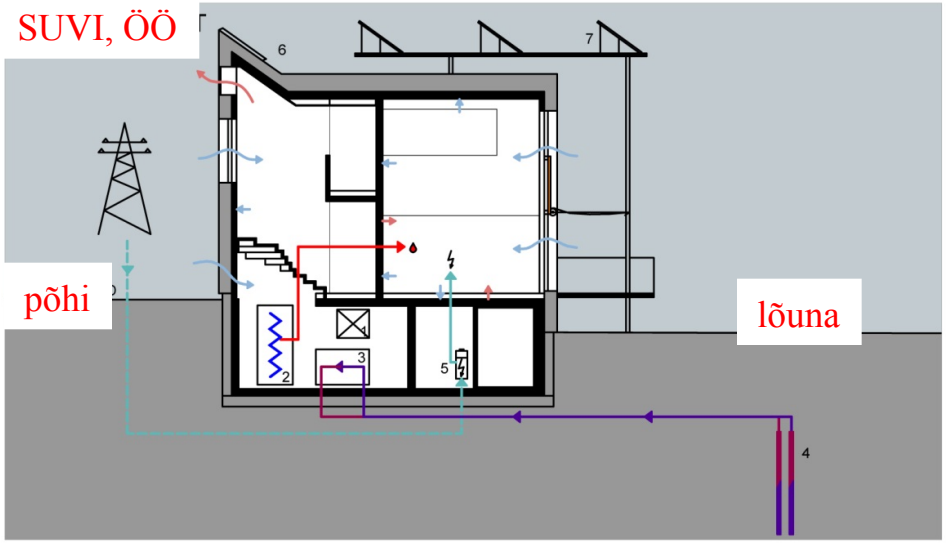
22 cm
massiivsavisein

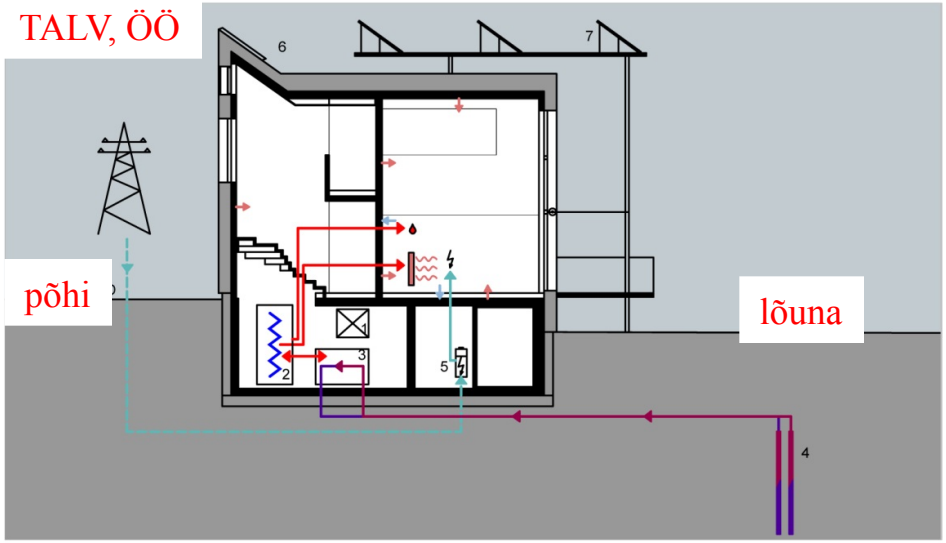
Metsa 5a, Põlva

Energiakontseptsioon



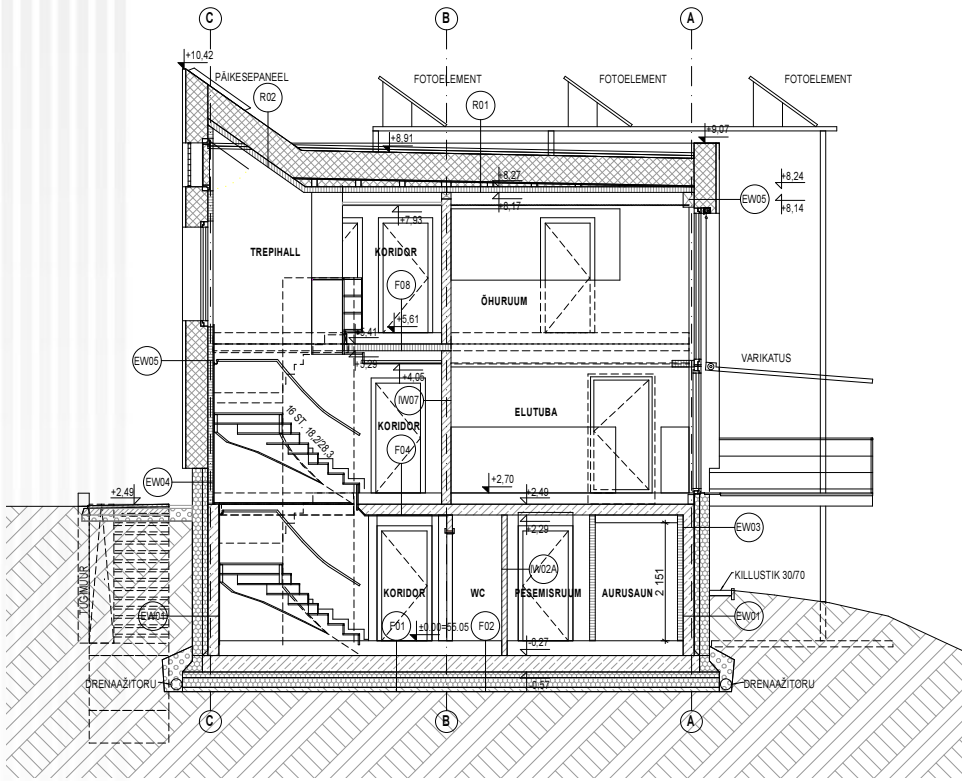






Metsa 5a, Põlva

Piirded



Sein

400 mm tselluvill, 94 mm KLH massiivpuit, U = **0,105** W/(m^{2}K)

Katus

500 mm EPS, 102 mm KLH
U = **0,079** W/(m^{2}K)

Sein vastu pinnast

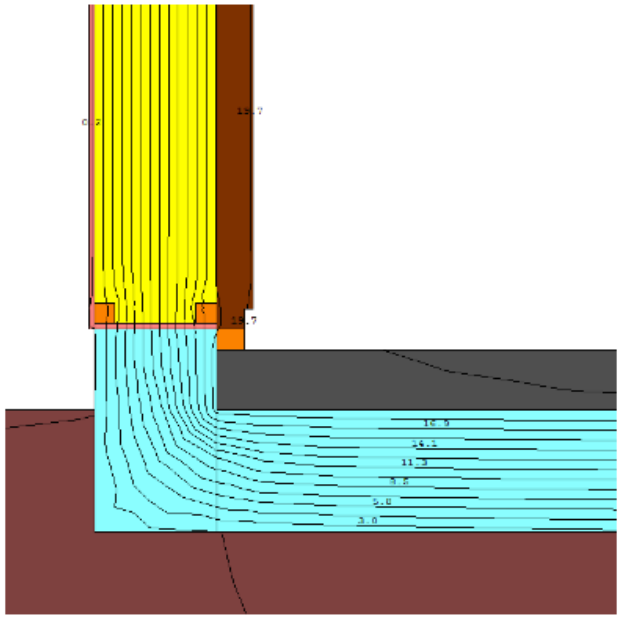
500 mm EPS, 200 mm betoon
U = **0,066** W/(m^{2}K)

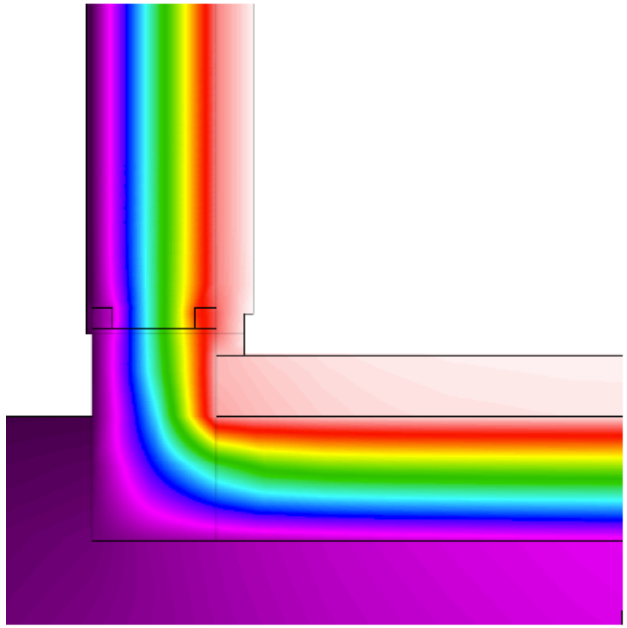
Põrand pinnasel

300 mm XPS, 300 mm betoon, 100 mm EPS
U = **0,086** W/(m^{2}K)

Metsa 5a, Põlva

Piirded

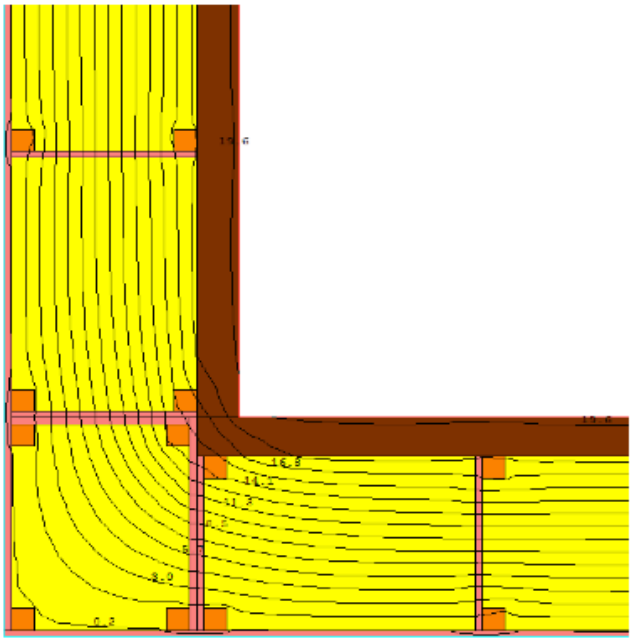


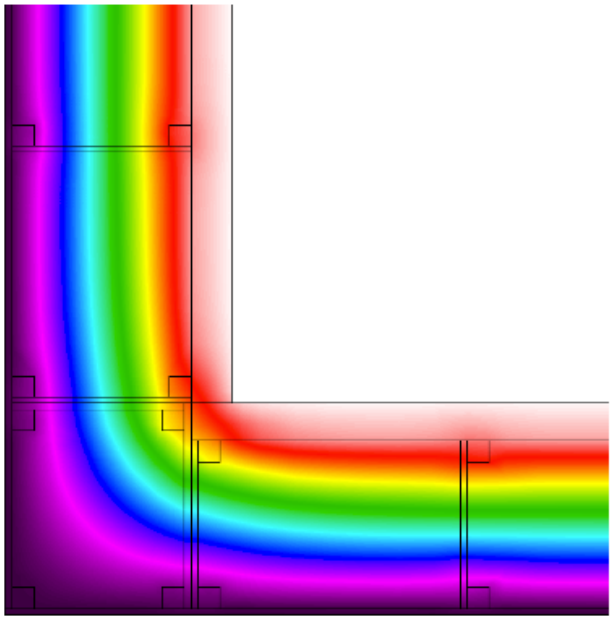


$U = 0{,}105\ W/(m^2K)$ $\Psi = -\ 0{,}014\ W/(mK)$

Metsa 5a, Põlva

Piirded





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

Piirded

Metsa 5a, Põlva

Piirded

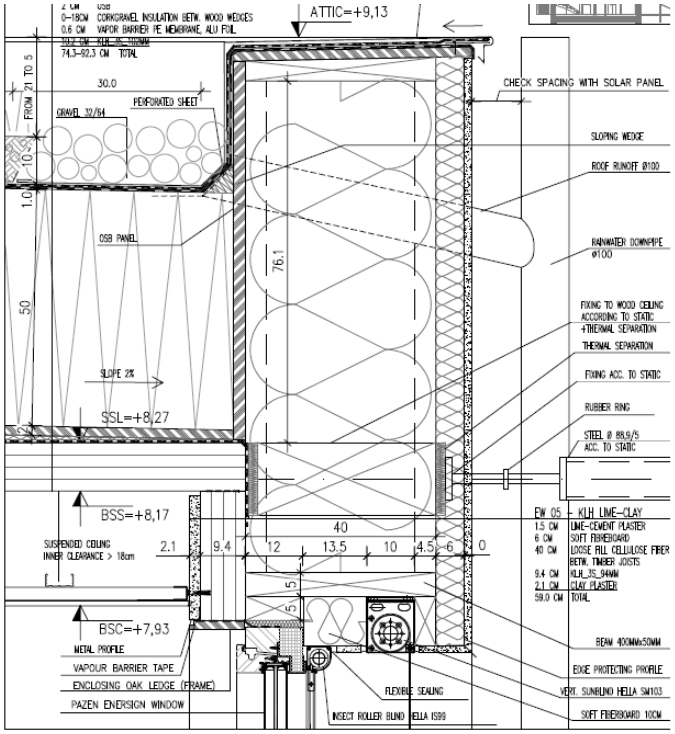
Metsa 5a, Põlva

Piirded

Metsa 5a, Põlva

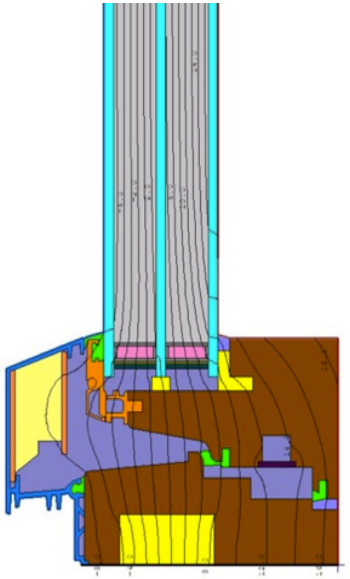
Piirded

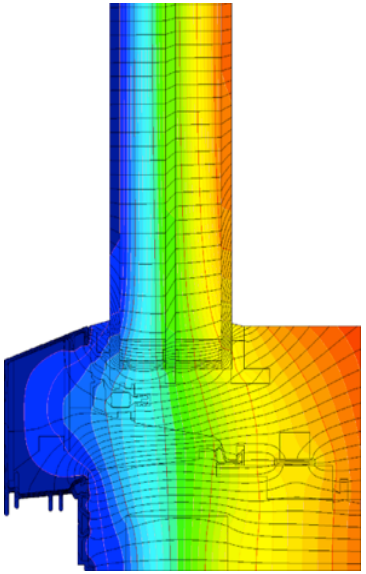
Metsa 5a, Põlva



Metsa 5a, Põlva

Piirded





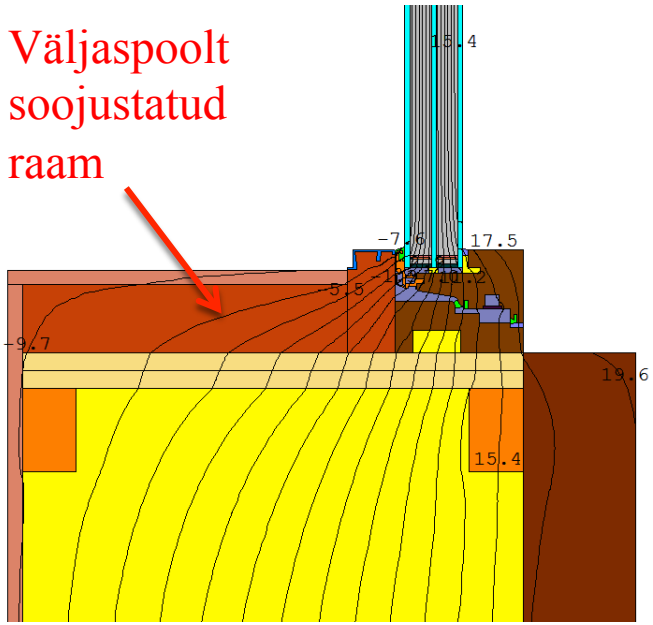
SmartWin avanev
U raam **0,77** W/(m^{2}K)
ψ spacer 0,026 W/(mK)
ψ raam-sein 0,010 W/(mK)

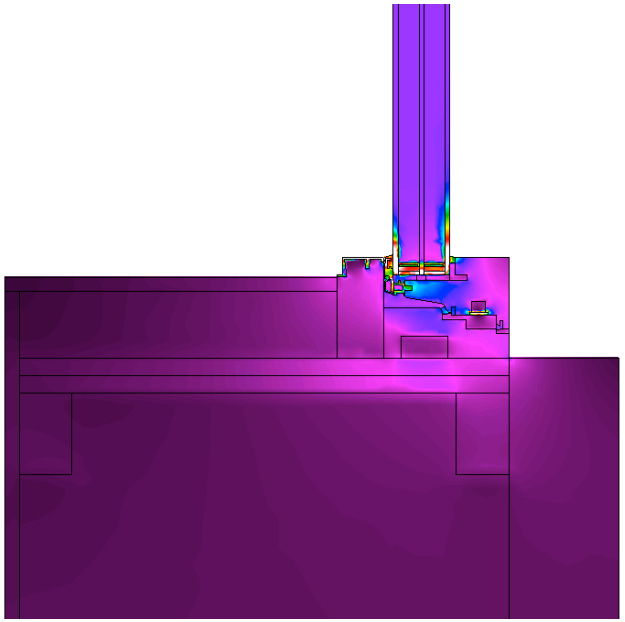
SmartWin mitteavanev
U raam **0,57** W/(m^{2}K)
ψ spacer 0,026 W/(mK)
ψ raam-sein 0,010 W/(mK)

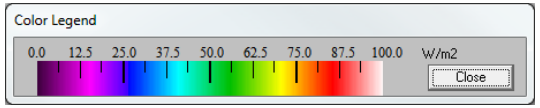
U klaas **0,54** W/(m^{2}K)
g - arv **0,50**

Metsa 5a, Põlva

Piirded



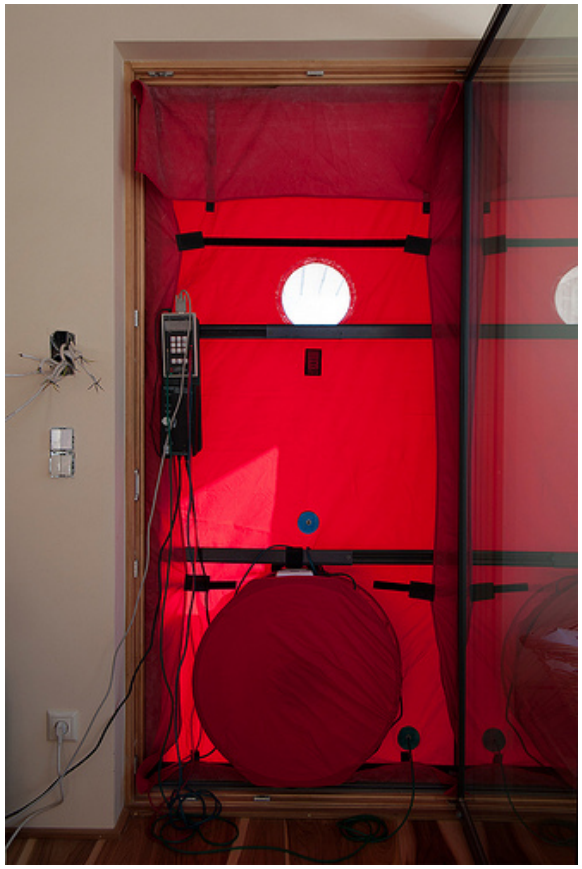




$$\Psi = 0{,}014\ \mathrm{W/(mK)}$$

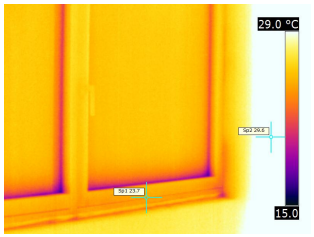
Piirded

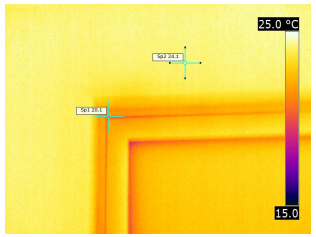
Metsa 5a, Põlva



Välistemp:
- 15 °C

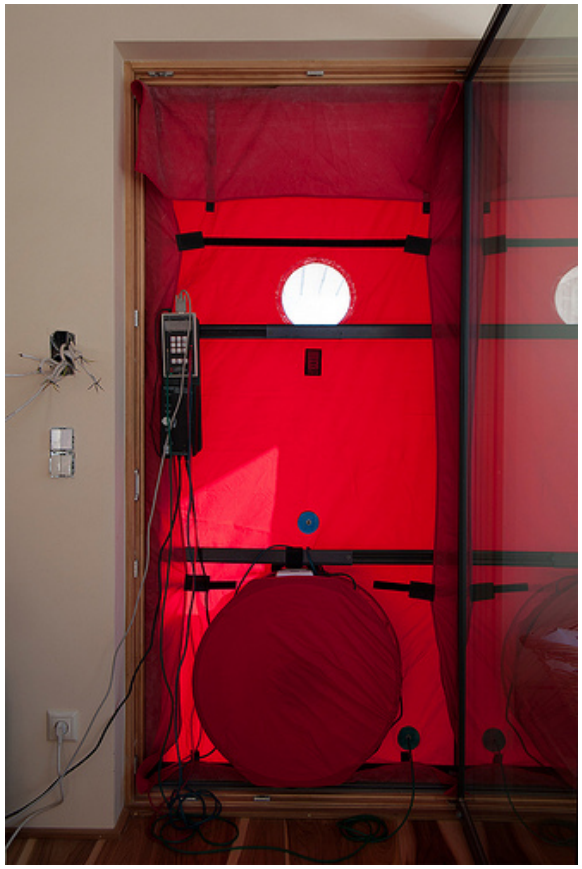
Sisetemp:
+ 22 °C

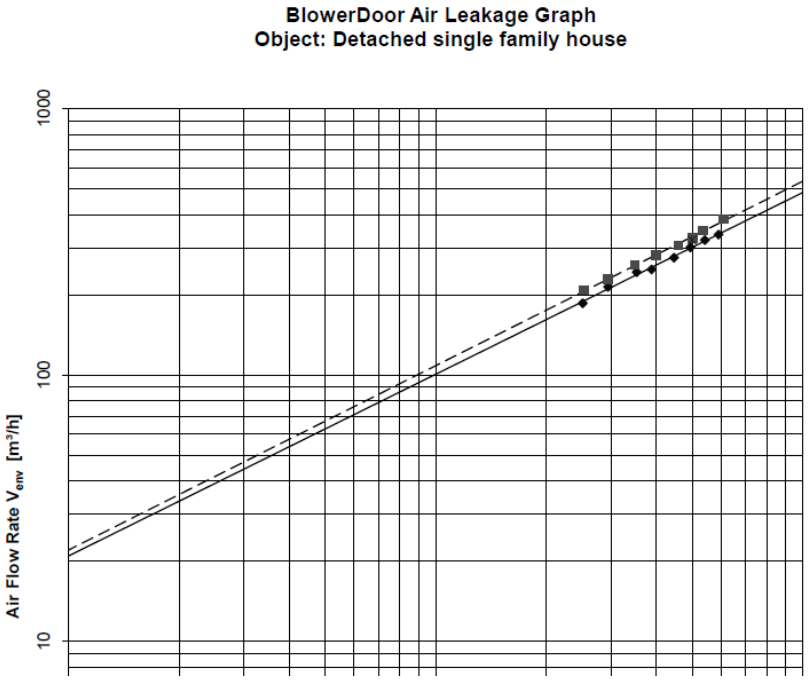




Piirded

Metsa 5a, Põlva





n_{50} = 0,36 1/h

Test A 14.03.13 EN 13829

Metsa 5a, Põlva

Ventilatsioon

Ventilatsiooniseade
Paul Novus 300
soojustagastus 93% PHI

Välisõhu eelsoojendus
Paul Sole Defroster SD-550,
226 m pikkune ring 40 mm toru

Metsa 5a, Põlva

Küte

2 x 1000 l akupaak
maasoojuspump
Viessmann Vitocal 300 G BWC
5,9 kW
COP = 4,5

2 x 80 m vertikaalsed puuraugud

Küte

Metsa 5a, Põlva

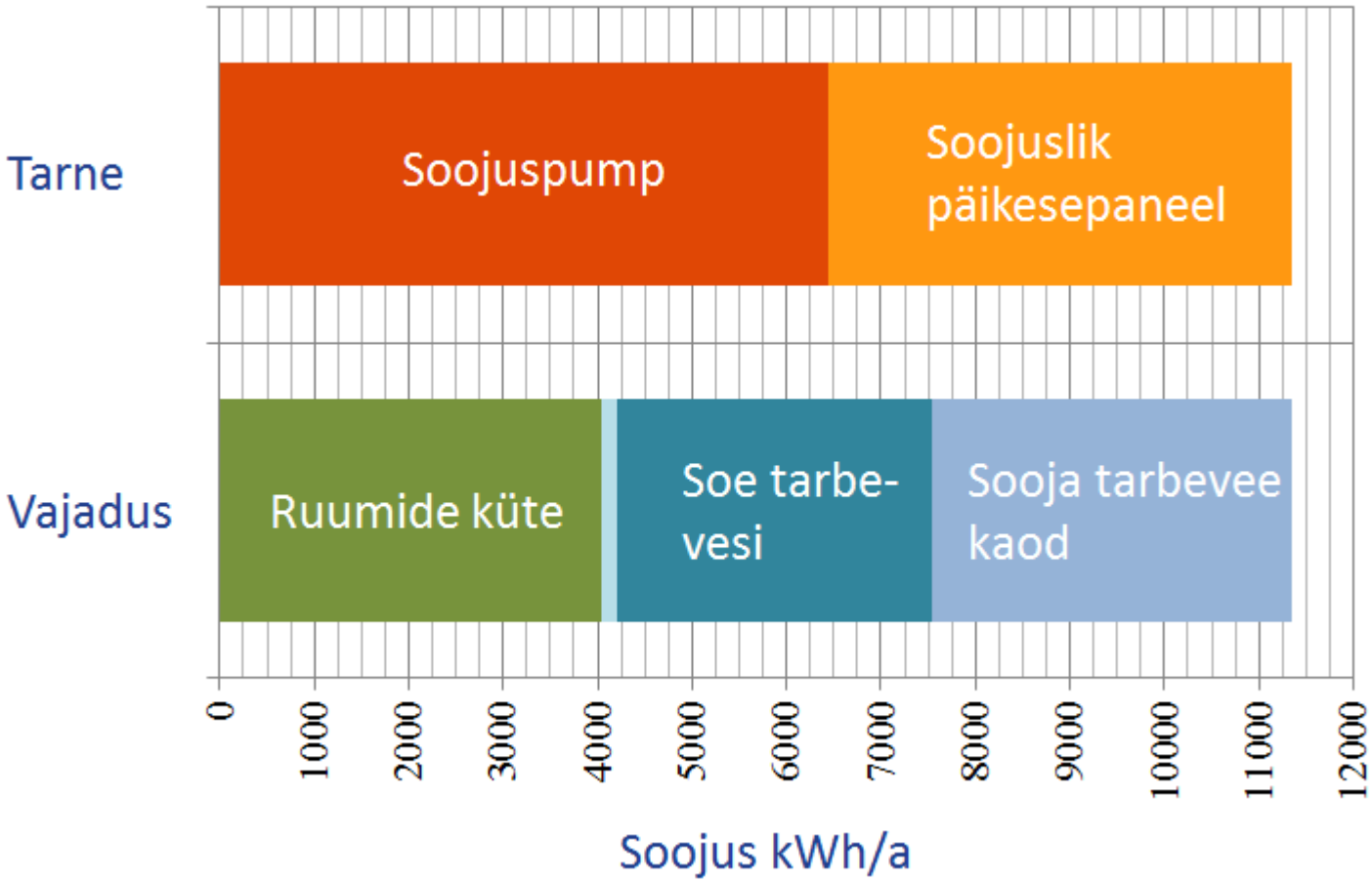
90 m^2 PV paneele
SolarWorld Sunmodule Plus
SW 196 Vario poly, 11 kWp

Sonnenkraft
päikeseküttesüsteem
2 x 1000 l akupaak, paneelid
12 m^2 katusega integreeritud
13 m^2 vertikaalne

Metsa 5a, Põlva

Soojus

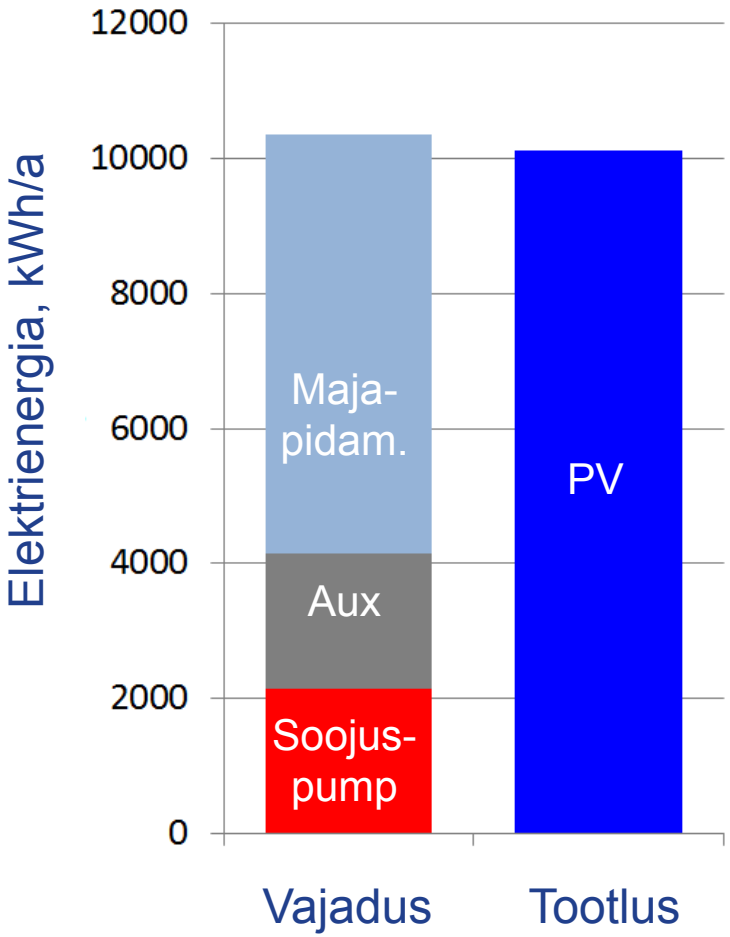
Arvutuslik



Metsa 5a, Põlva

Lõppenergia

Arvutuslik



Elektrienergia vajadus:
kõik kokku:
10 360 kWh

PV tootlus
10 120 kWh/a

Neto vajadus ≈ 0

Tänan tähelepanu eest!