

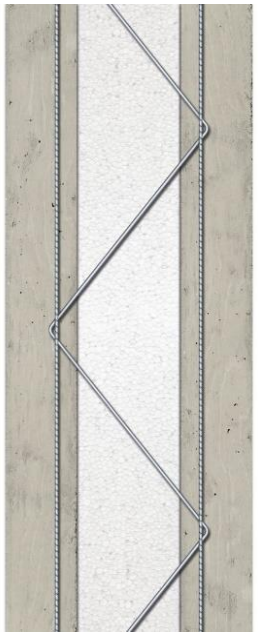
R/B SEINAELEMENTIDE DIAGONAALSIDEMETE KÜLMASILD JA NENDE MÕJU HOONE ENERGIATÕHUSUSELE

Reimo Piir, Paul Klõšeiko, Martin Kiil

02.09.2020

SISSEJUHATUS / UURIMISVAJADUS (1)

- R/b *sandwich*-paneelide kasutamine Eestis
  - 2009-2014: min 235 projekti (Pärna 2016)
- SW-paneelide olemuslikud probleemid
- Hoonete energiatõhusus
- Surve kasutada **jäika soojustust**



Allikas: www.peikko.com

MAJANDUS- JA KOMMUNIKATSIOONI-MINISTEERIUM

Eesmärgid, tegevused Uudi pres

Avaleht > Uudised > Aastast 2020 saab ehitada vaid A-energiaklassiga h...

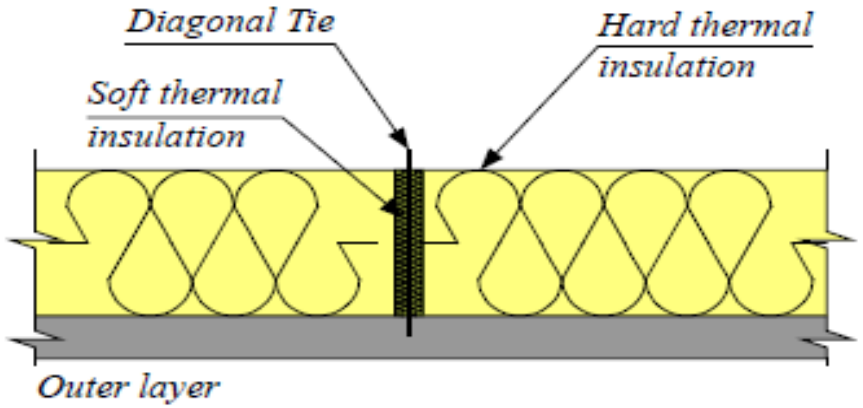
Aastast 2020 saab ehitada vaid A-energiaklassiga hooneid

18.01.2018

Soojusläbivus U [W/(m²K)]	Vajalik mineraalvilla paksus x [mm]	Vajalik PIR paksus y [mm]	Vahe [mm]
0,09	410	260	150
0,10	370	240	130
0,11	340	210	130
0,12	310	200	110
0,13	280	180	100
0,14	260	170	90
0,15	250	160	90
0,16	230	150	80

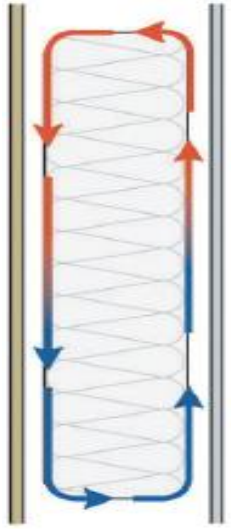
SISSEJUHATUS / UURIMISVAJADUS (2)

- Materjalitootjate tehnilised juhendid:
  „Jäiga soojustuse korral on vuukides vajalik pehme soojustus“
- Juhendite järgimine tegelikkuses?
- Mõju juhenditest kõrvalekaldumisel
- Õhkvahe mõju varasemates uuringutes



Allikas: Peikko Group. Ties and Connector Pins : Technical Manual. 2018

Hüpotees: õhkvahes tekib õhuringlus, mis tõstab oluliselt tarindi soojusläbivust



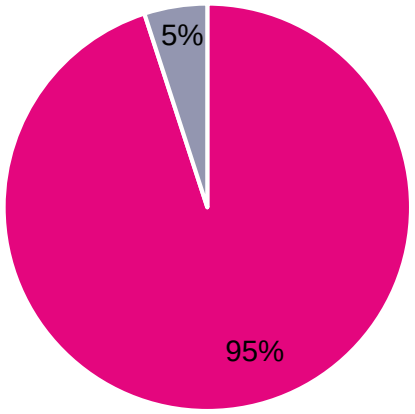
Allikas: Straube, J. Building Science Digest 011: Thermal Control in Buildings. 2011.

TÖÖ EESMÄRGID

- Erinevate vuugilahenduste **katseline uurimine kliimakambris**
- **Arvutusmudelite** ja katsetulemuste võrdlus
- Külmasilla **mõju tüüpilise tarindi** soojusläbivusele
- Külmasilla **mõju hoone** energiatõhususele

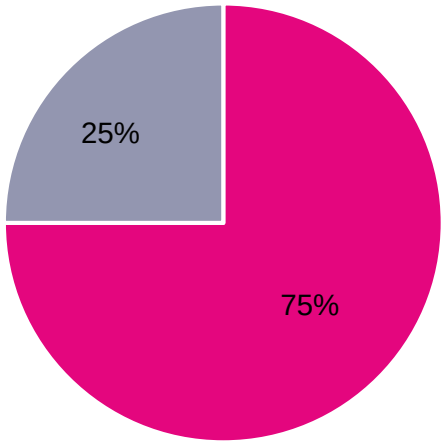
OBJEKTIKÜLASTUSED

Objekt 1 (Vill)



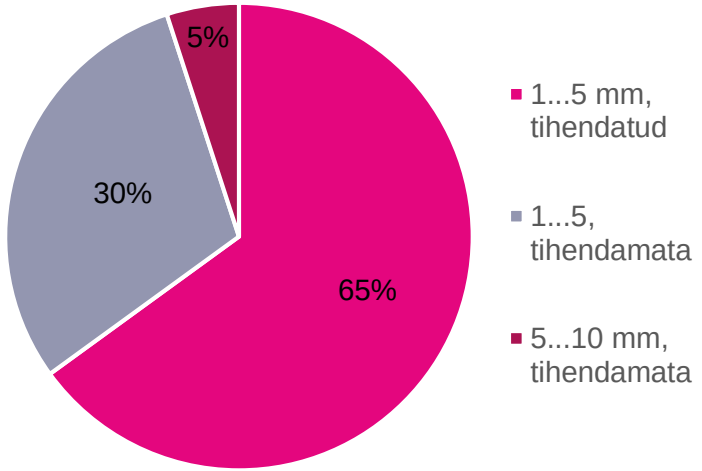


Objekt 2 (Vill)





Objekt 3 (EPS)

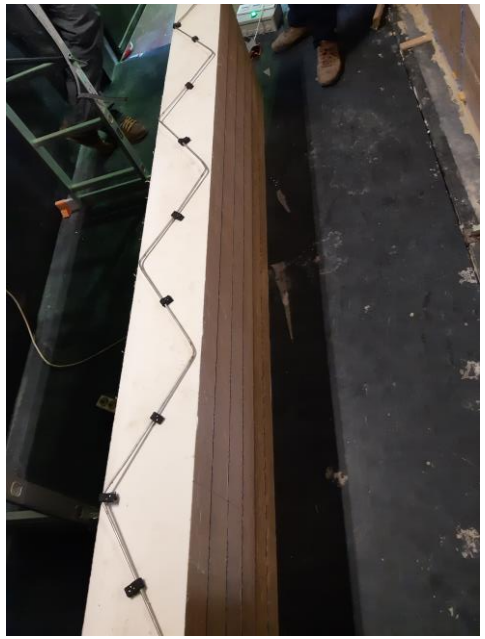


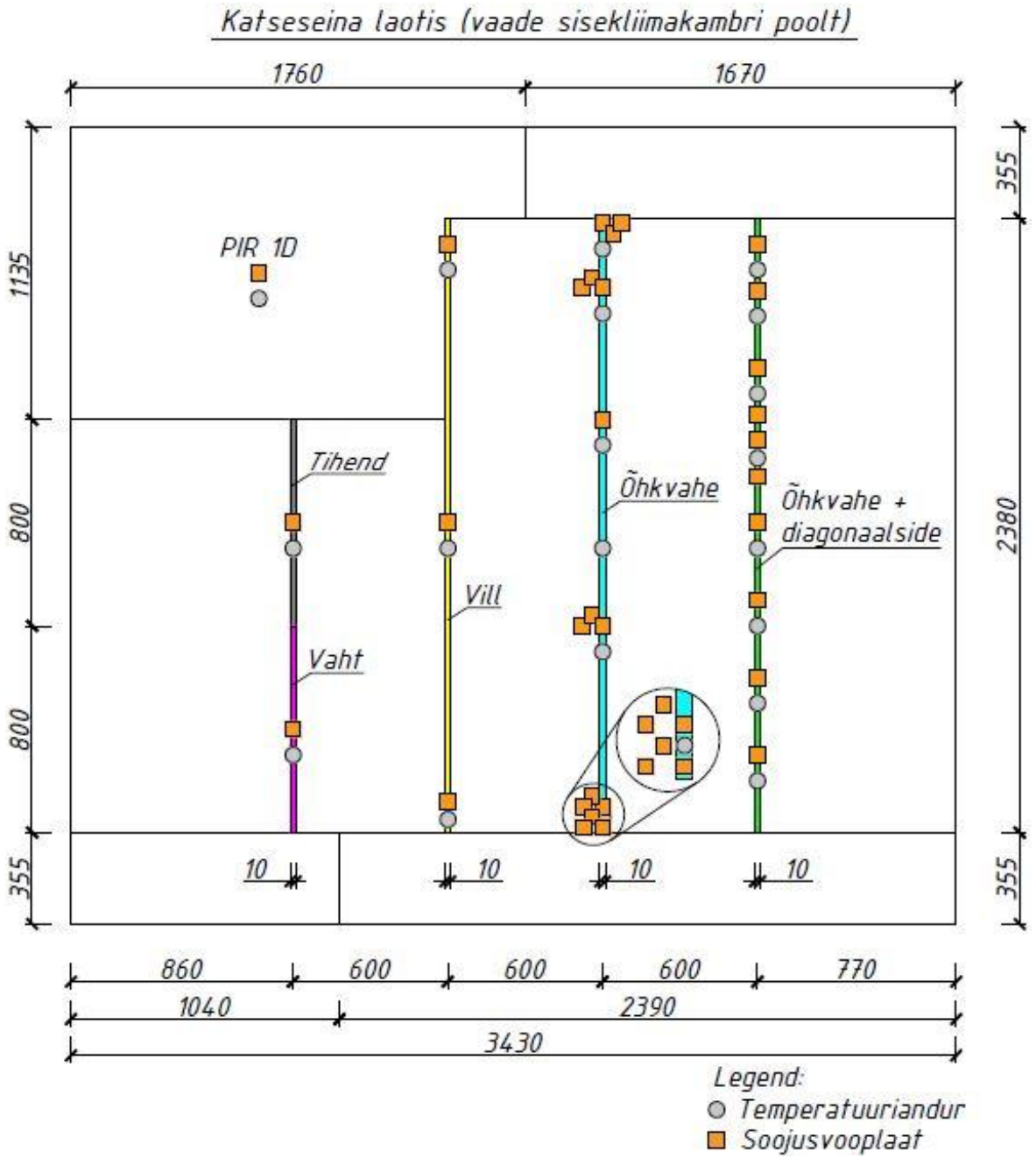


Ka mineraalvilla puhul võivad vuugid probleemseks osutuda!

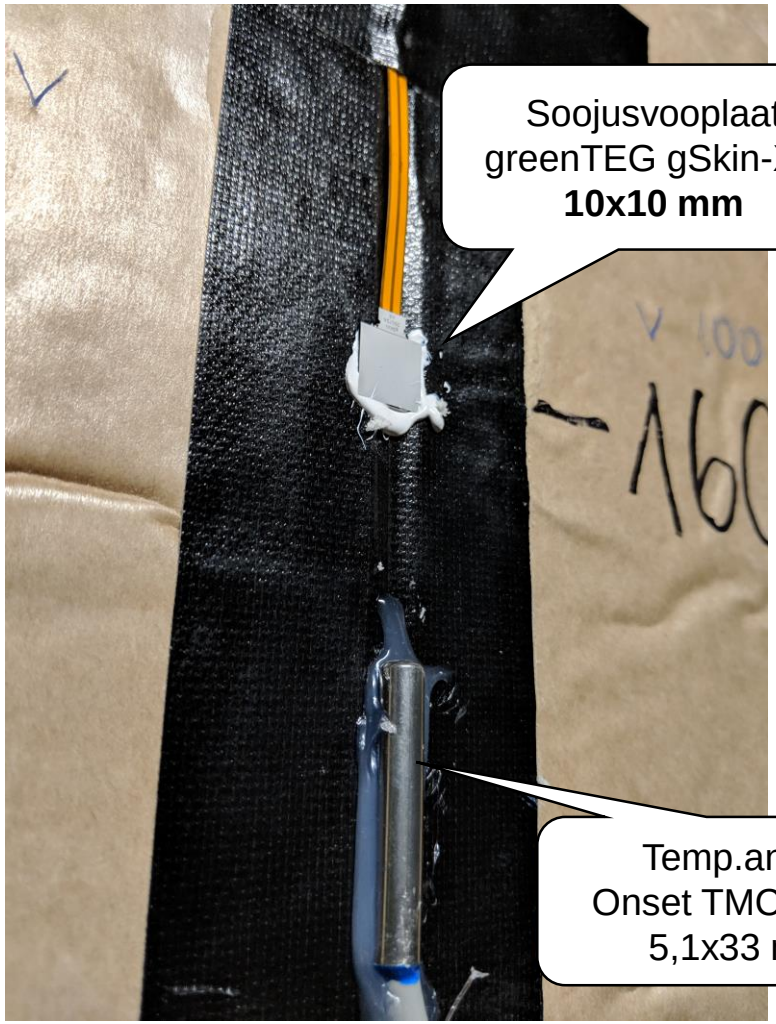
KLIIMAKAMBRIKATSE (1)

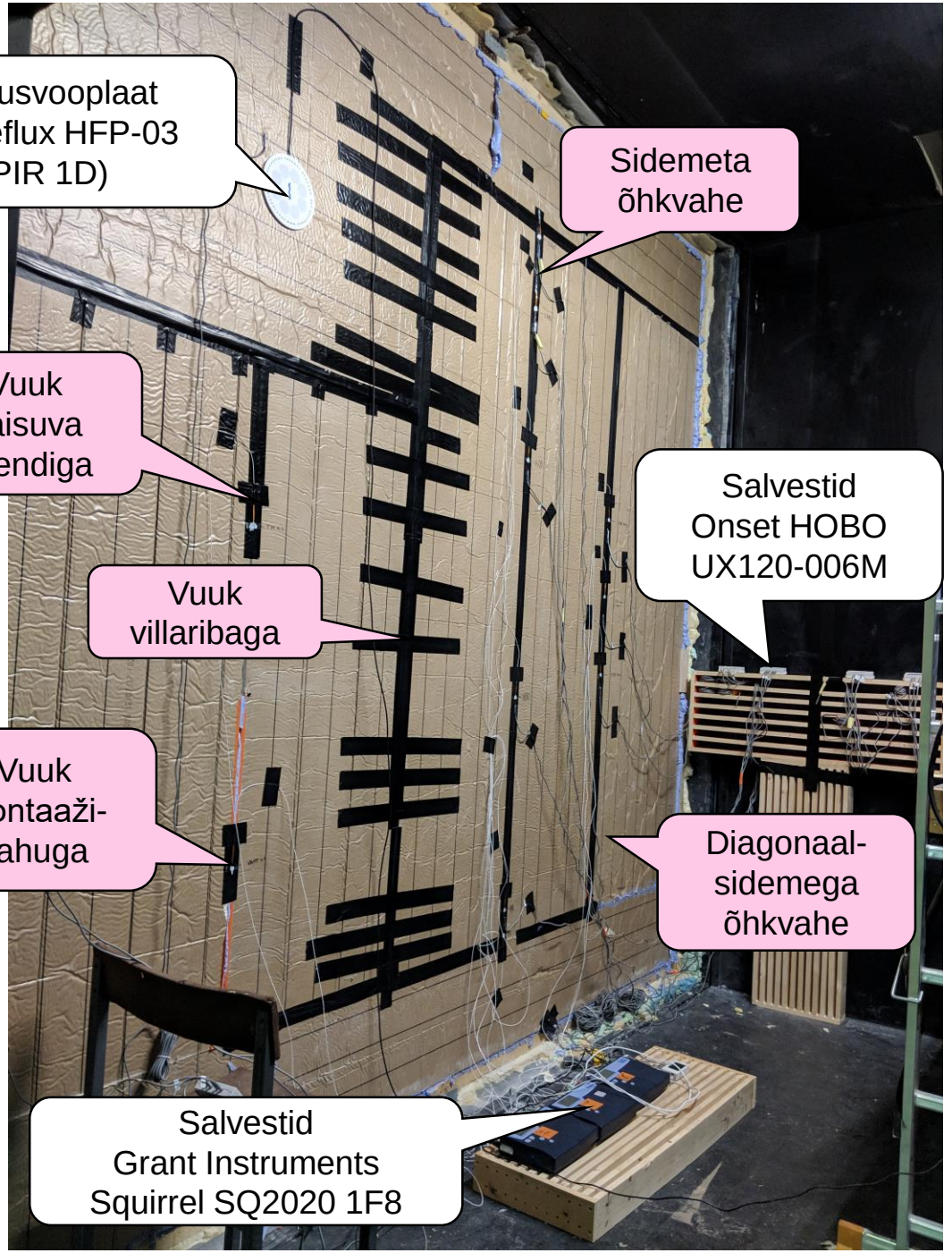
- Katsetamine 2019 veebruar – aprill
- 200 mm PIR
  - λ_D = 0,022 W/(m·K)
- 36 temperatuuriandurit
- 16+1 soojusvooplaati
- Ääretingimused:
  - Sisetemperatuur +20 °C
  - Välistemperatuurid:
    - +10 °C
    - 0 °C
    - -10 °C
    - -20 °C
    - -30 °C



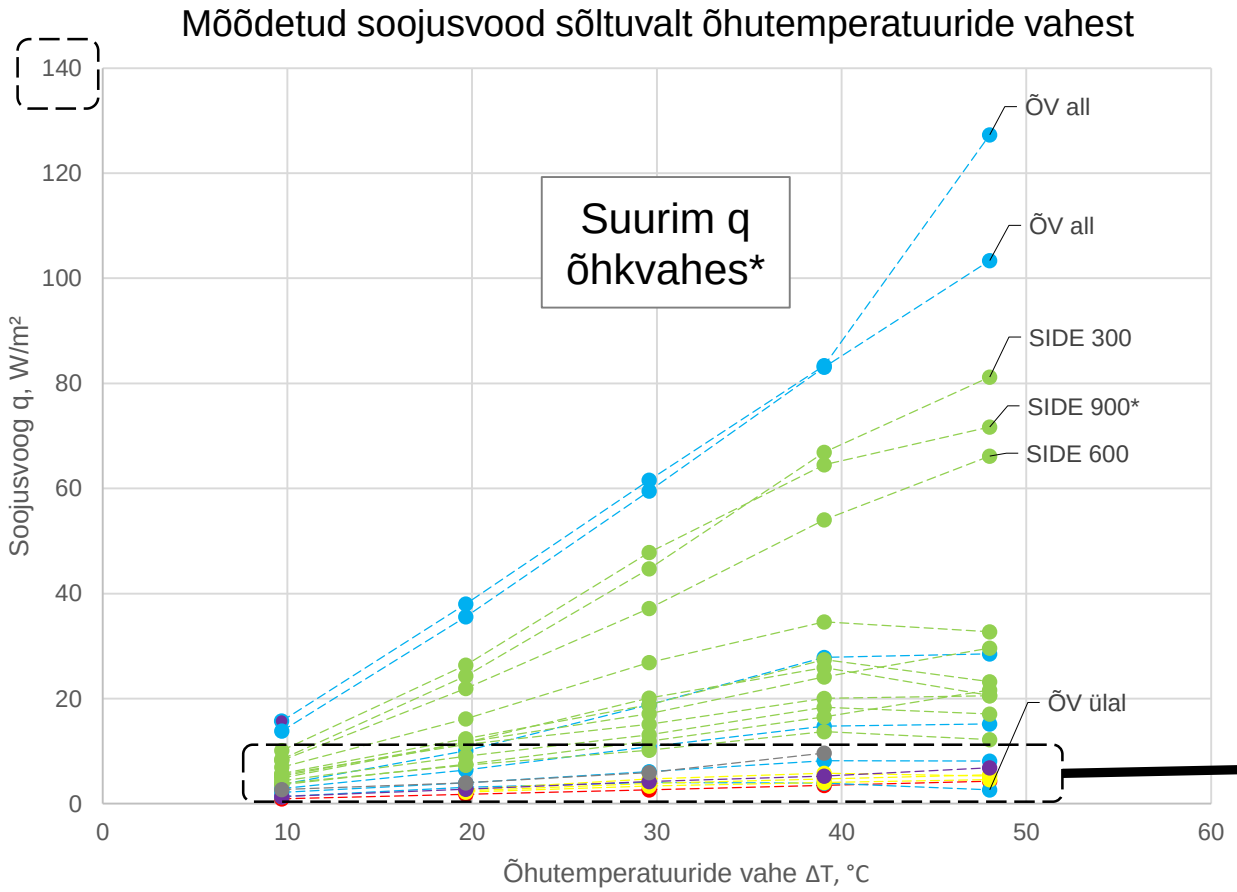


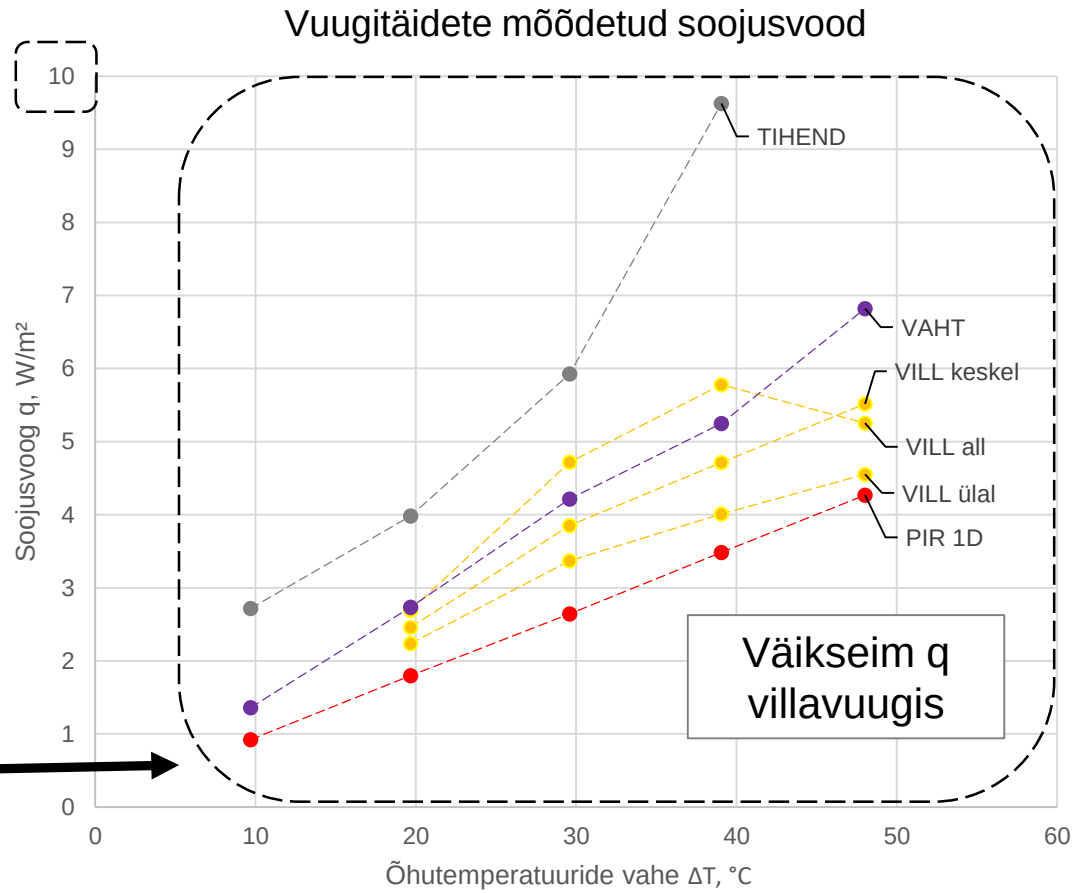
KLIIMAKAMBRIKATSE (2)





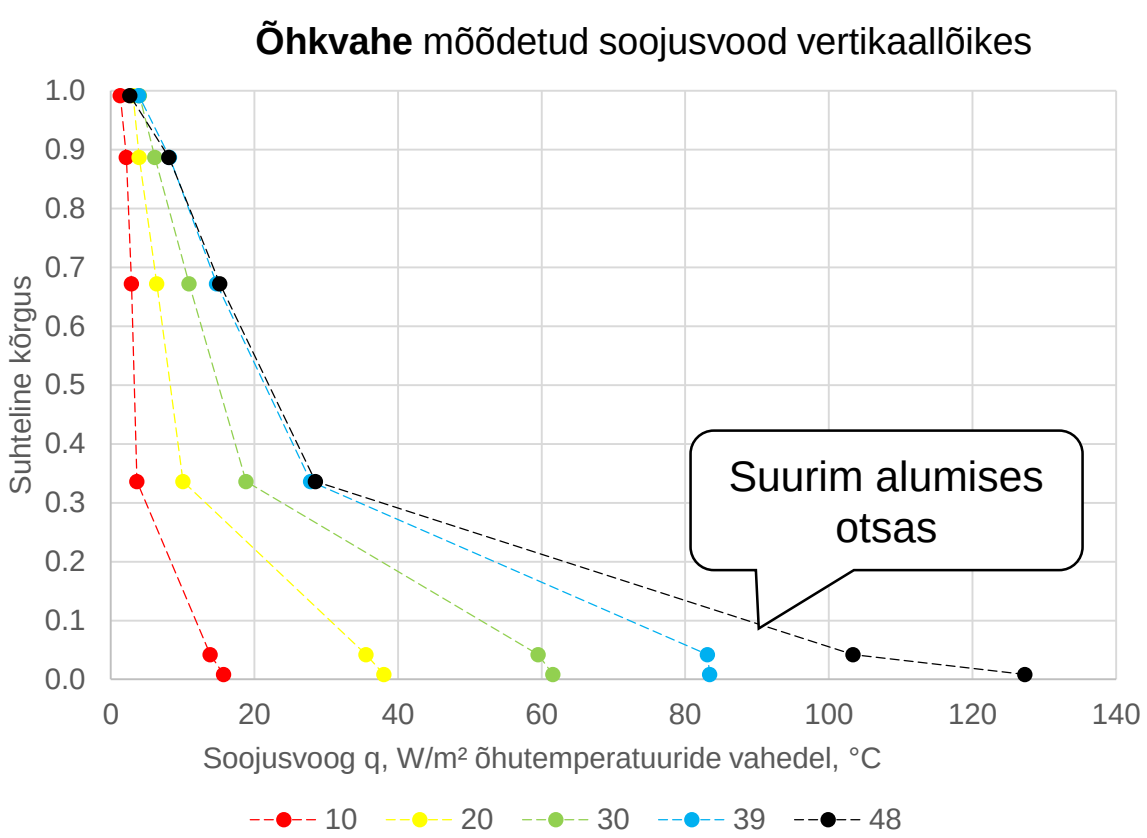
KATSETATUD VUUKIDE VÕRDLUS

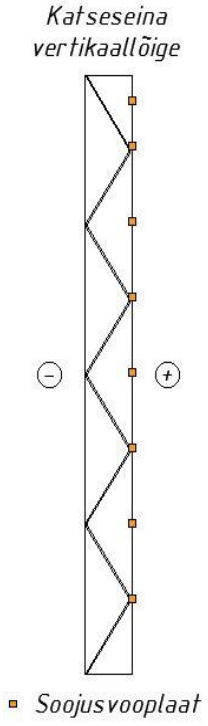


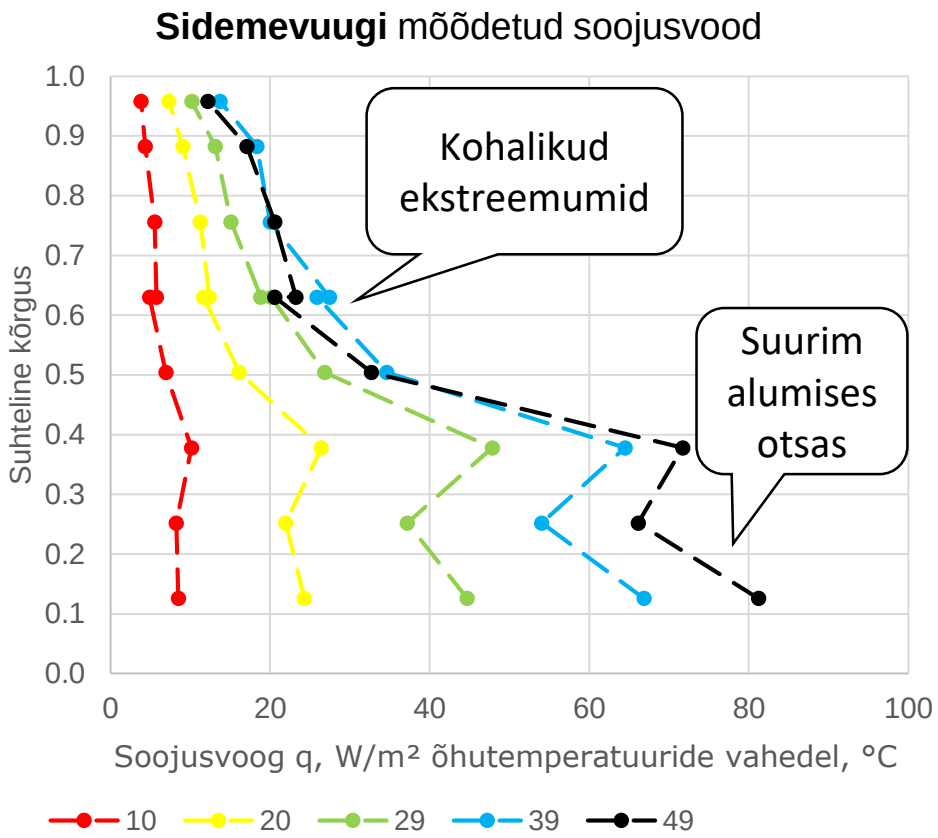


Vuugitäidete soojusvood olid **suurusjärgu võrra väiksemad** tühjade õhkvahede soojusvoogudest:
igasugune vuugi tihendamine vähendab oluliselt külmasilla mõju

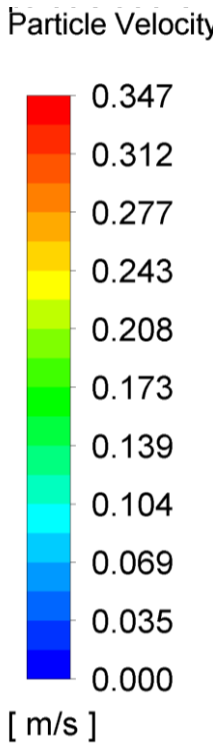
KATSETULEMUSED

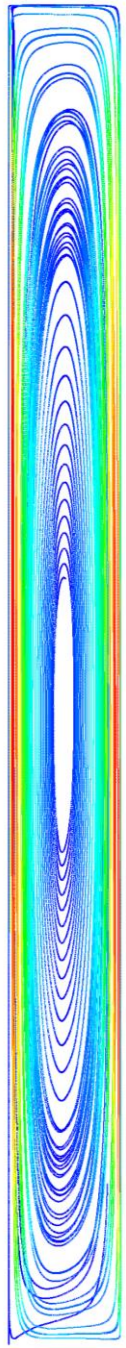


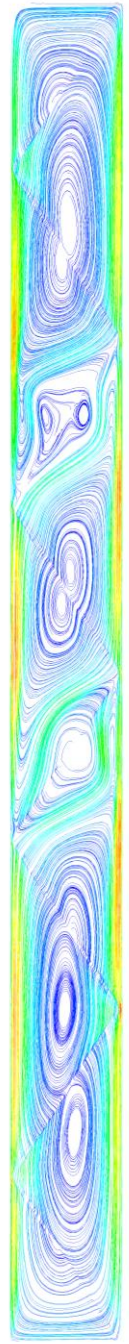


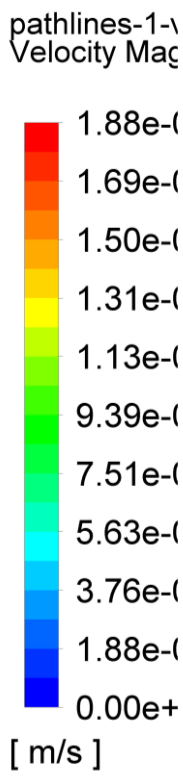


CFD MODELLEERIMINE
ÕHU LIIKUMINE ÕHKVAHES









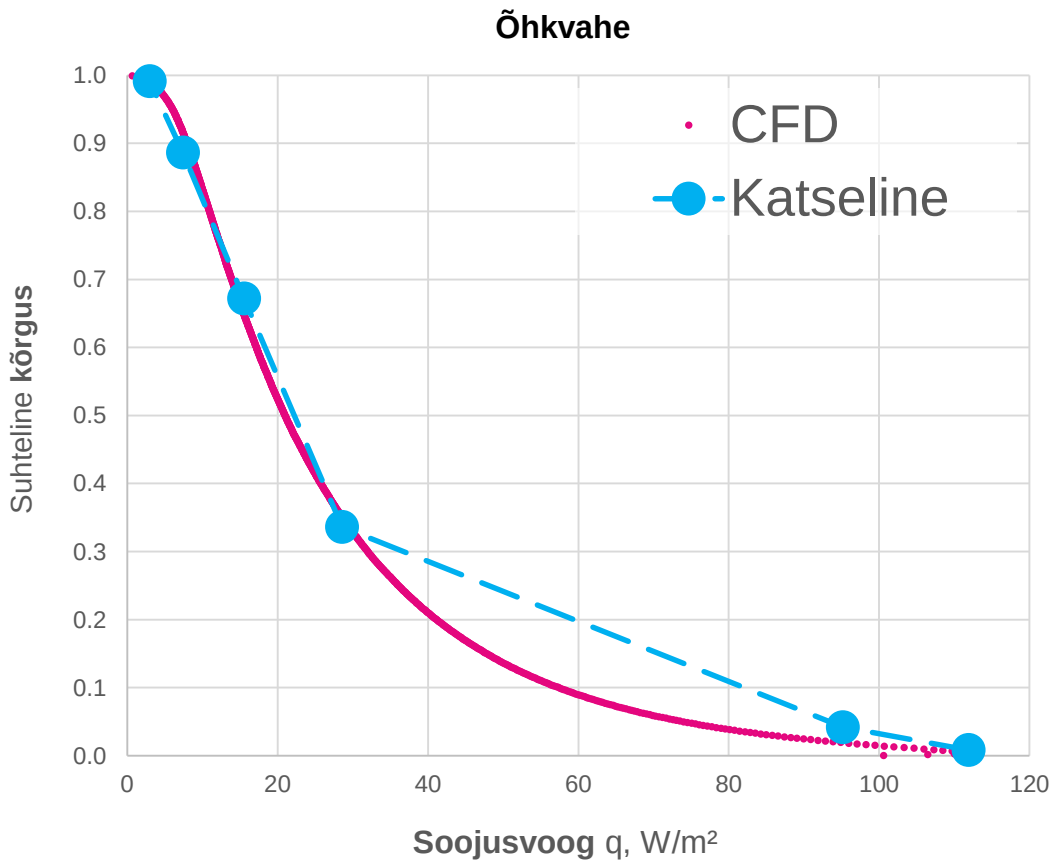
TAL TECH

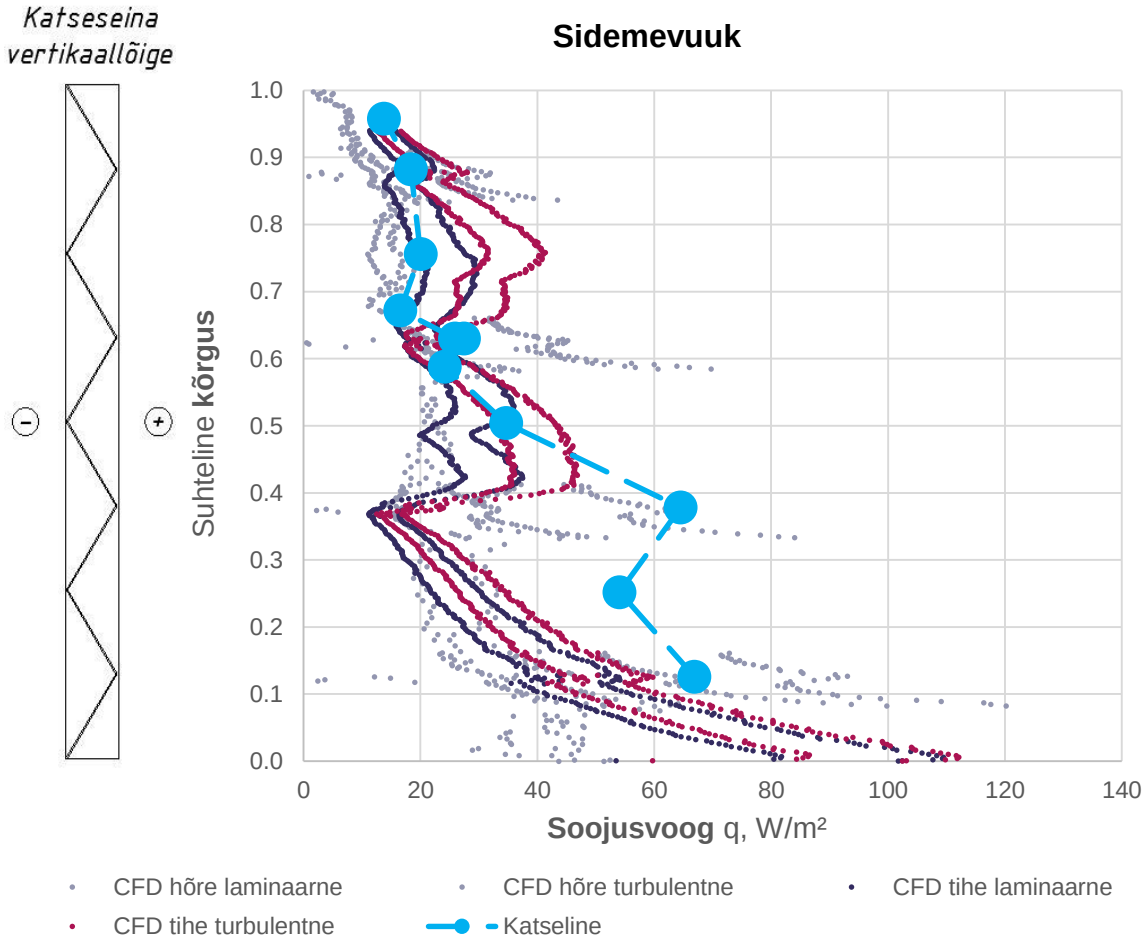
TÜHI ÕHKVAHE

ÕV + DIAGONAALSIDE

KATSETULEMUSTE VÕRDLUS CFD SIMULATSIOONIDEGA

- Tarkvara: ANSYS Fluent 2019 R1 Academic

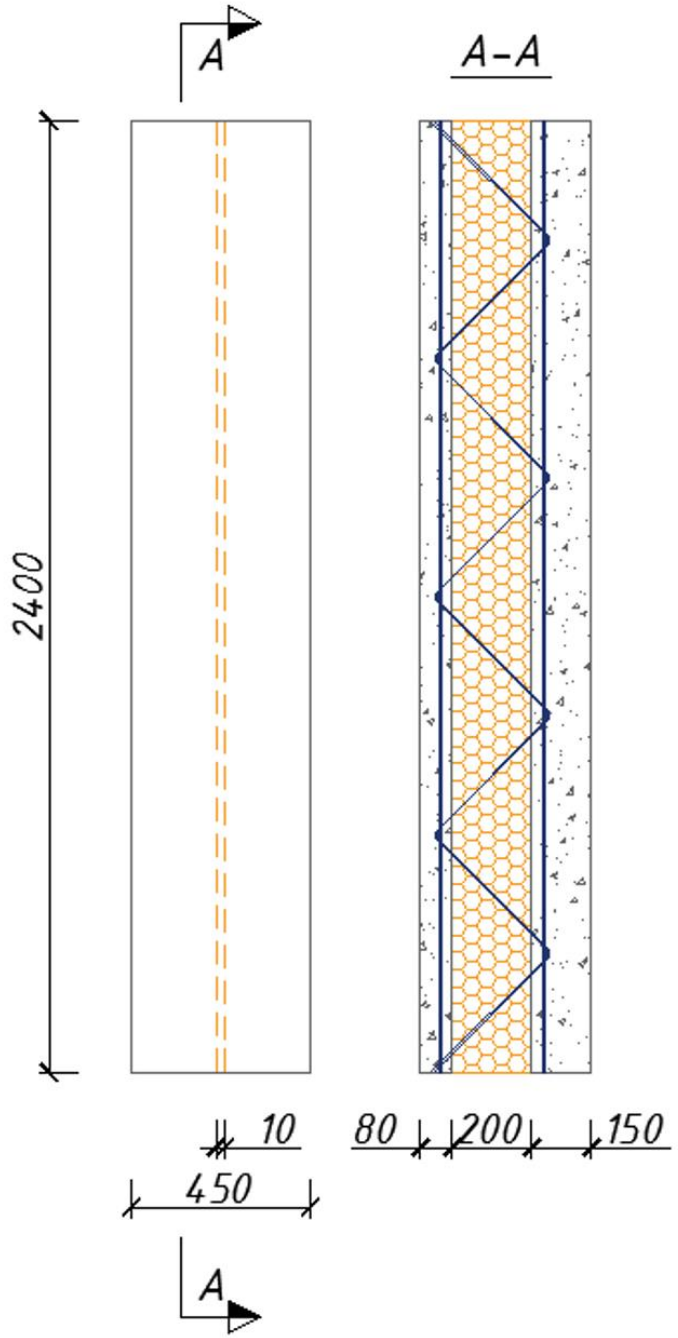


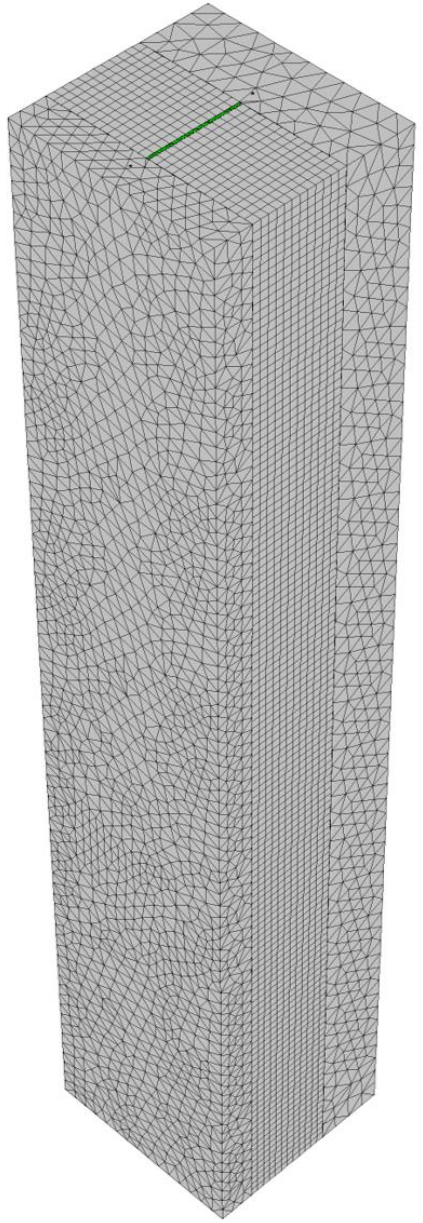


CFD arvutuslik hinnang veaga tagavara kahjuks võrreldes katsetulemustega

„TÜÜPILINE SEINATARIND“

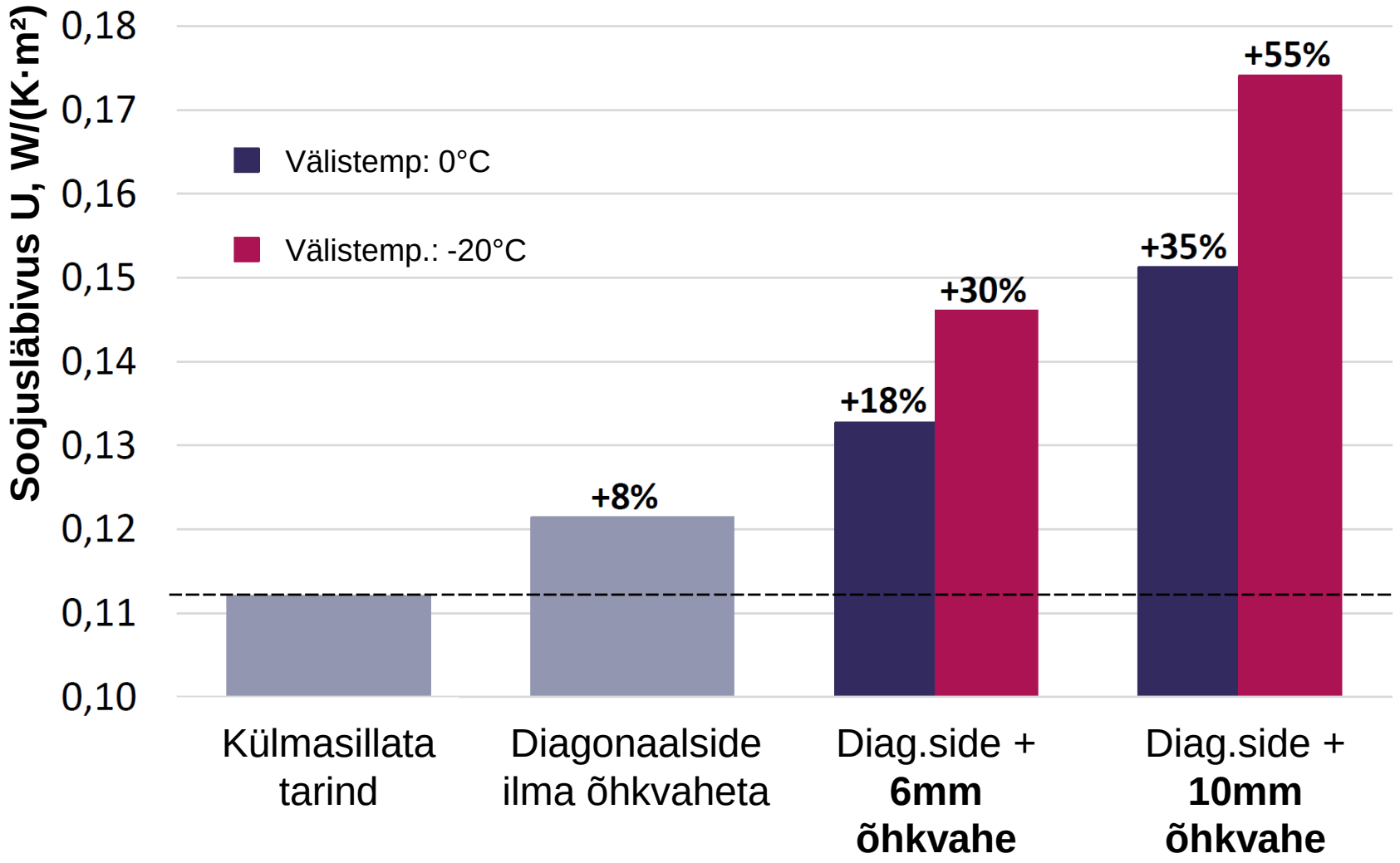
- 200mm PIR
- Sidemete samm 450mm





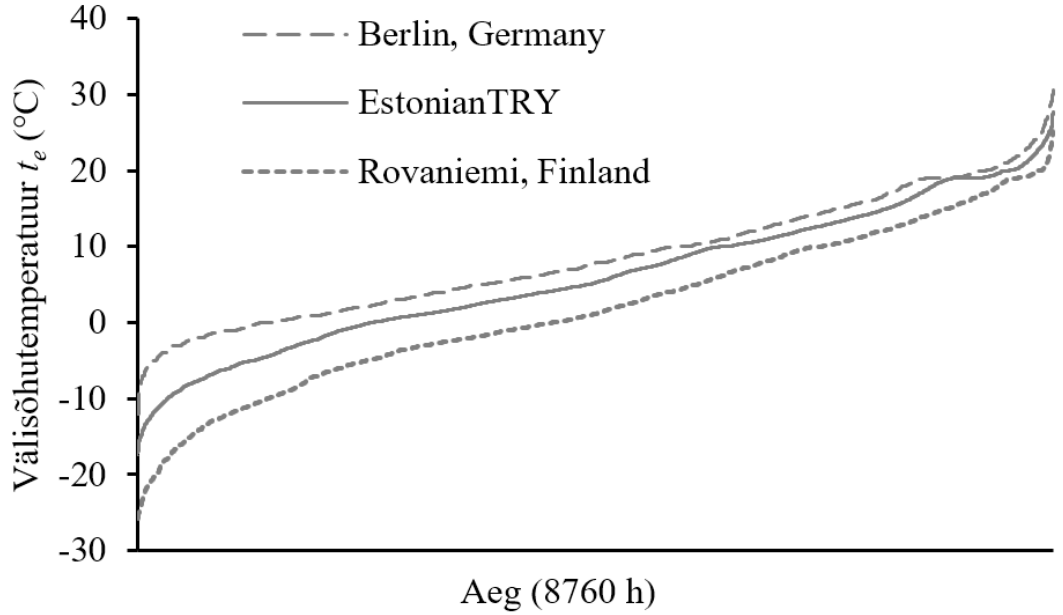
ARVUTUSTULEMUSED
MÕJU TÜÜPILISELE SEINATARINDILE

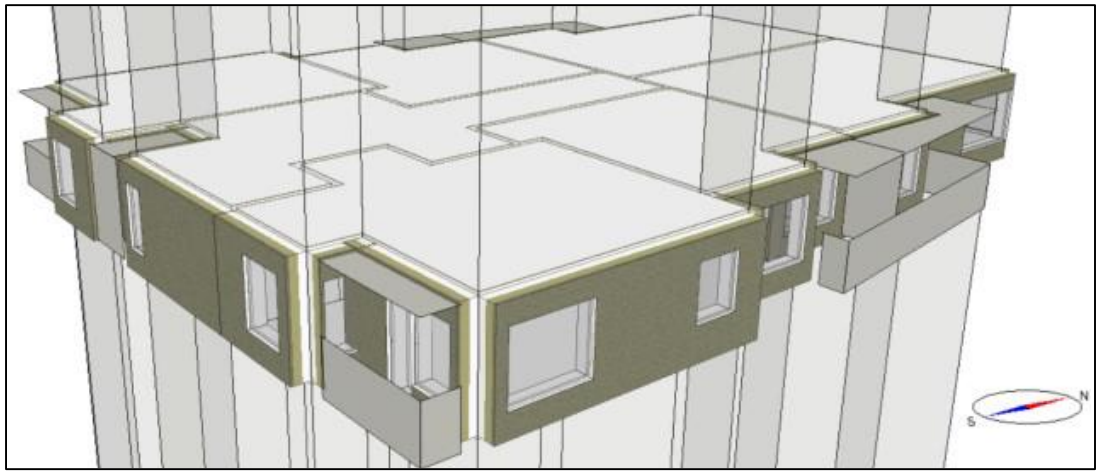
- PIR 200mm
- Sidemete samm: 450mm

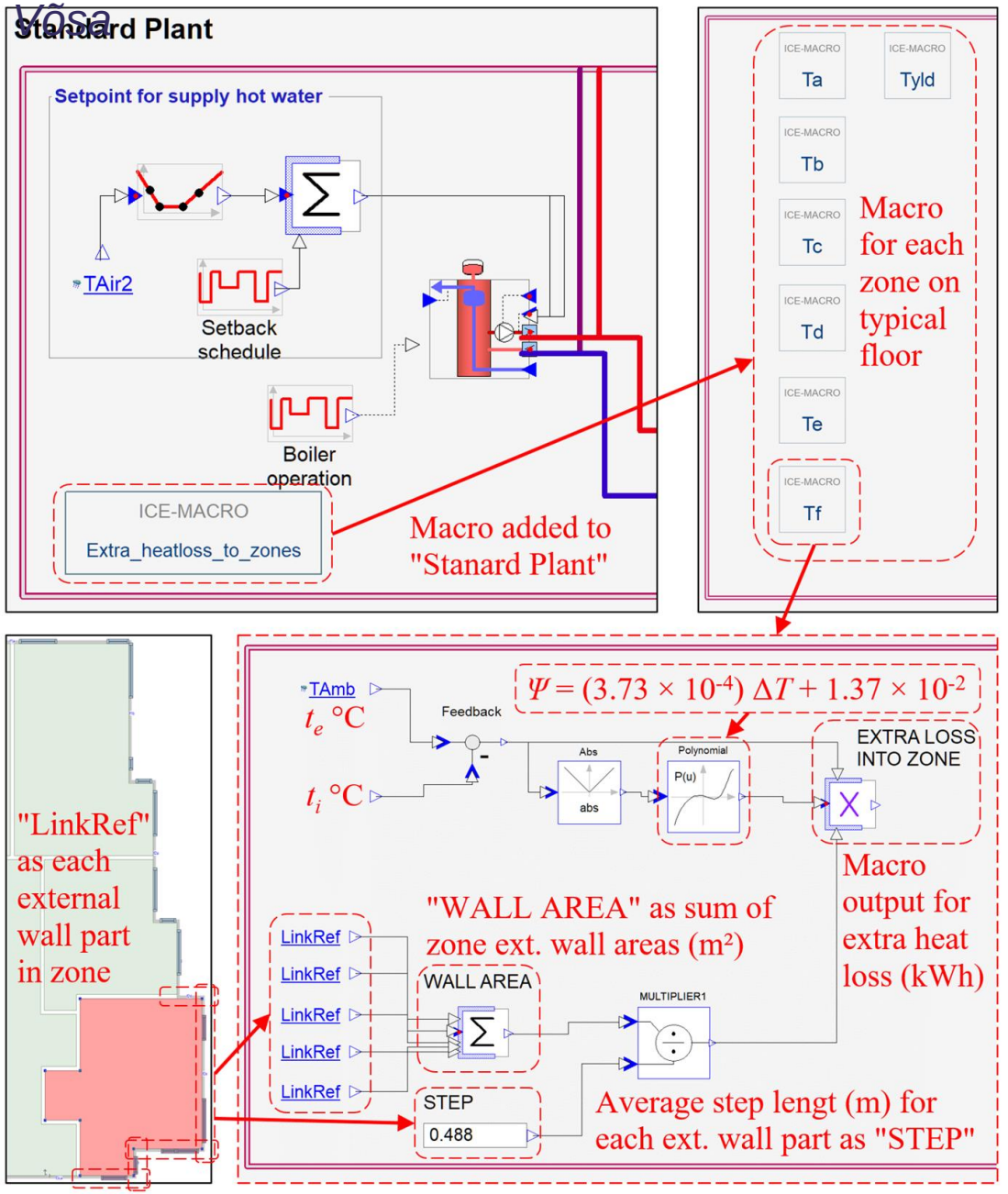


Karl-Villem Võsa

ARVUTUSTULEMUSED
MÕJU TÜÜPILISELE TORNELAMUL

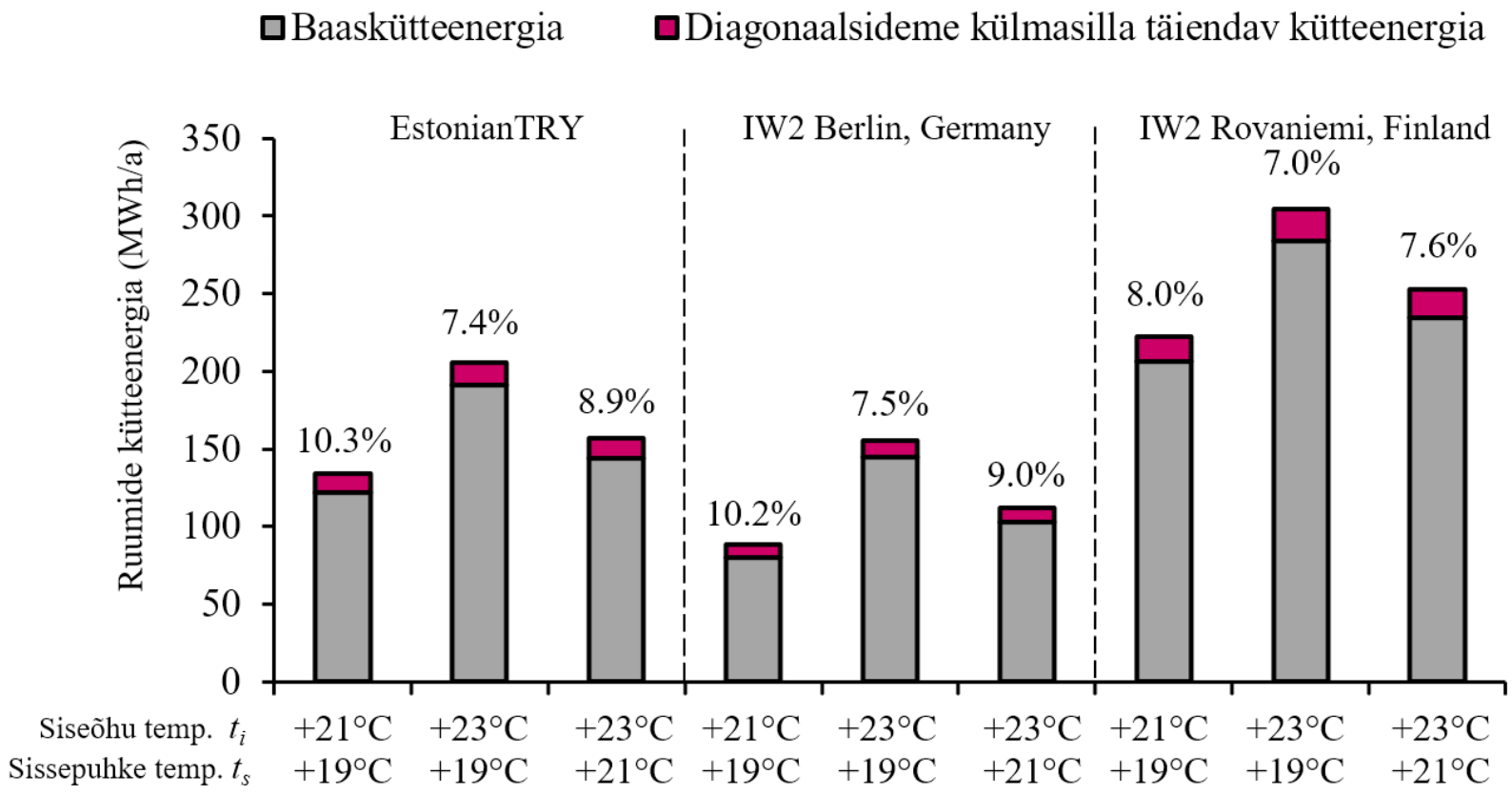






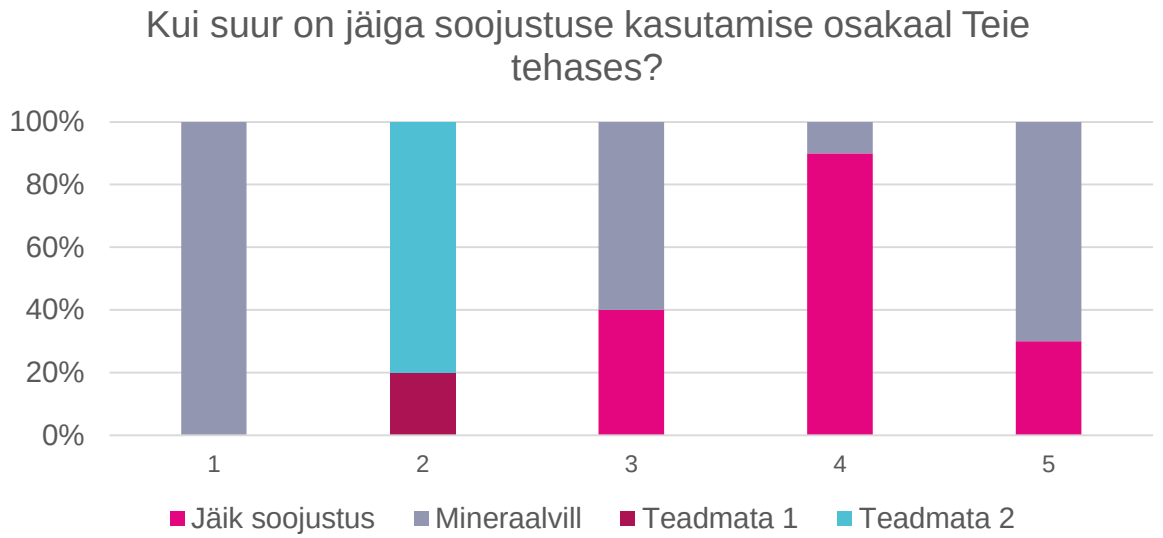
ARVUTUSTULEMUSED
MÕJU TÜÜPILISELE TORNELAMULE

- ~1% ETA +1.4 kWh/(m²·a)
- 45 m² krt ~7 €/a
- 70 m² krt ~11 €/a

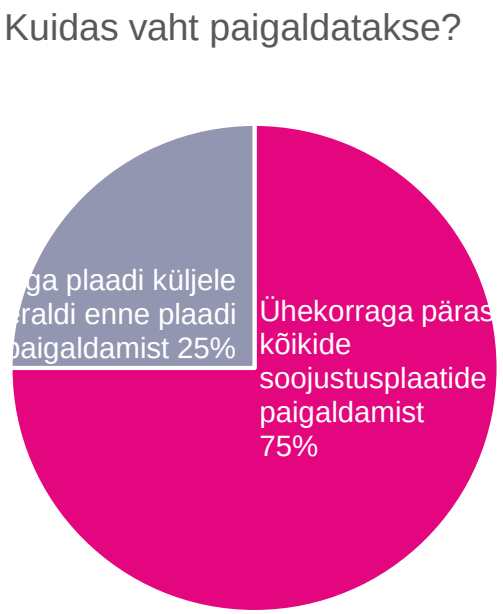


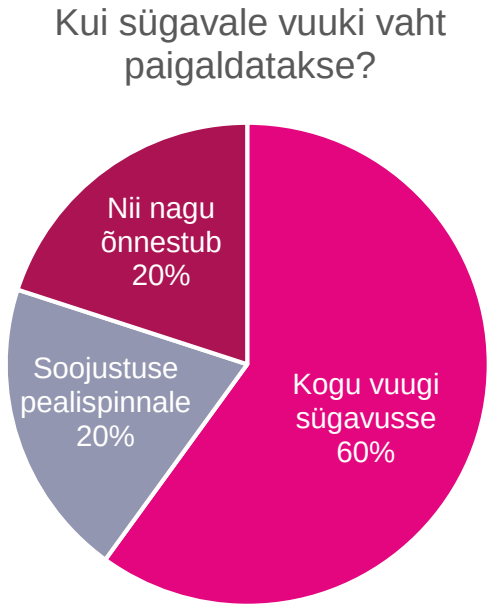
ELEMENDITOOTJATE KÜSITLUS

- Vastamisaktiivsus – 42%
- Diagonaalside on üldkasutatav



Järeldus: jäiga soojustuse kasutamise osakaal ja vuugi tihendamise meetodid erinevad, kuid tootmistehnoloogilist arenguruumi on enamikus tehastes





KOKKUVÕTE

- Tihendamata õhkvahes tekib **õhuringlus**
- **Külmasillal on arvestatav mõju**, eriti tihendamata vuugi korral
- **Igasugune vuugi tihendamine vähendab** soojusvoogu läbi vuugi **suurusjärgu võrra**

Külmasilla mõju ≈ min.vill
→ PIR asendus

(ühtlaselt halva paigalduse korral)

Soojusläbivus U [W/(m²K)]	Vajalik mineraalvilla paksus x [mm]	Vajalik PIR paksus y [mm]
0,09	410	260
0,10	370	240
0,11	340	210
0,12	310	200
0,13	280	180
0,14	260	170
0,15	250	160
0,16	230	150