CHALMERS

Evaluation of a modified co-heating test for in-situ measurements of thermal transmittance of single family houses

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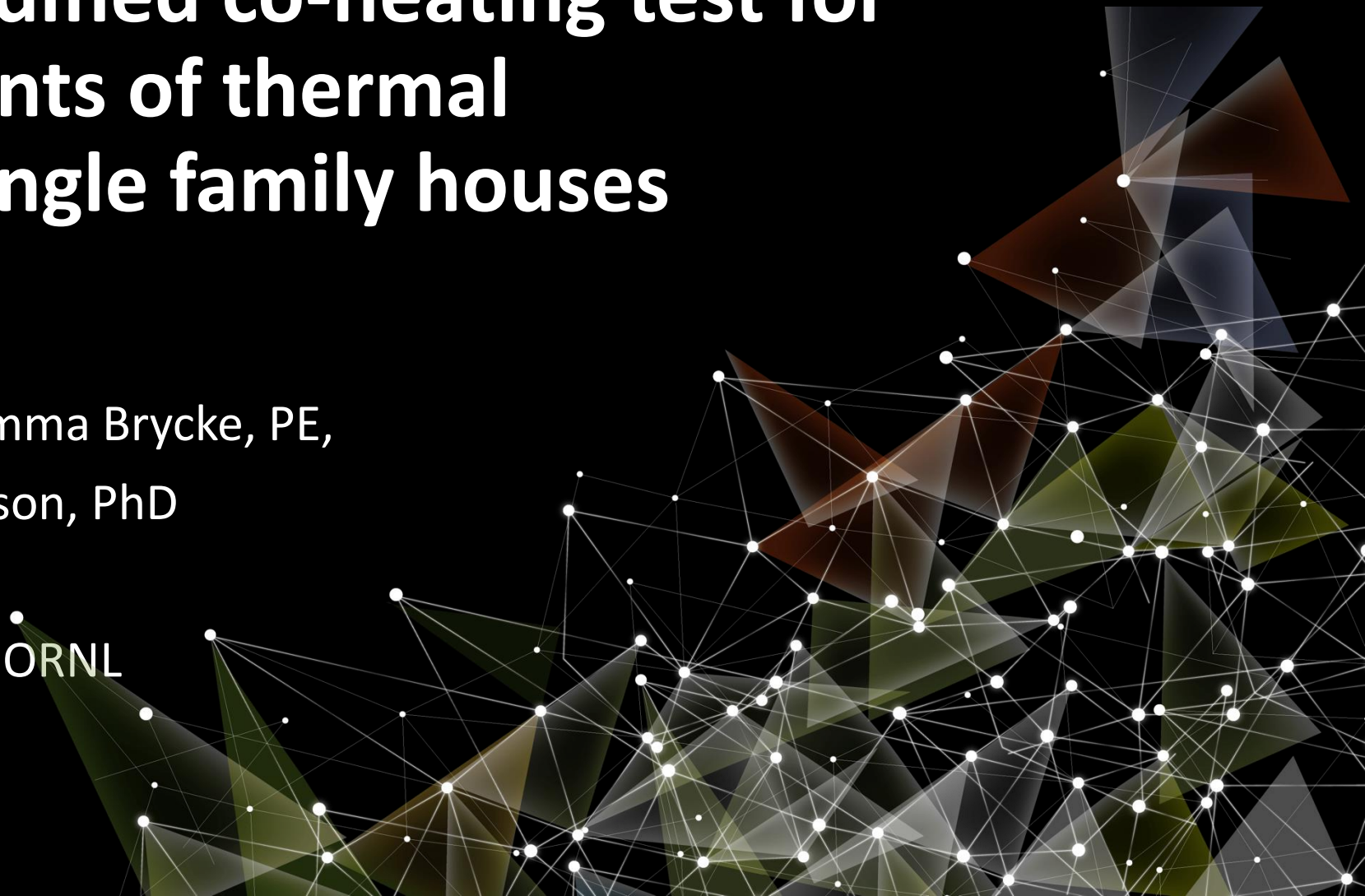
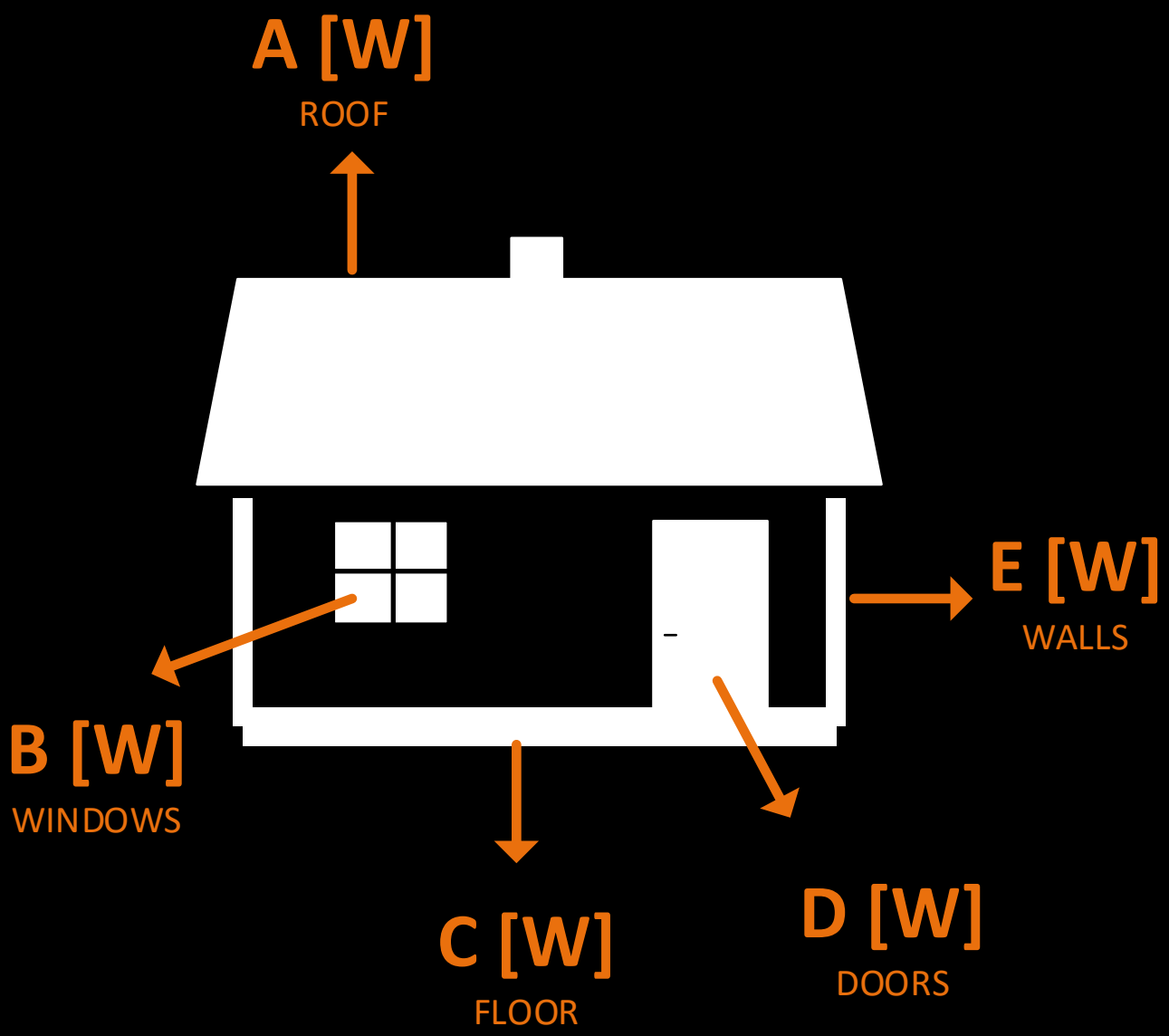


Buildings XIII, 2016

Co-heating test

Method for in-situ evaluation of overall ***H***eat ***L***oss ***C***oefficient of a building

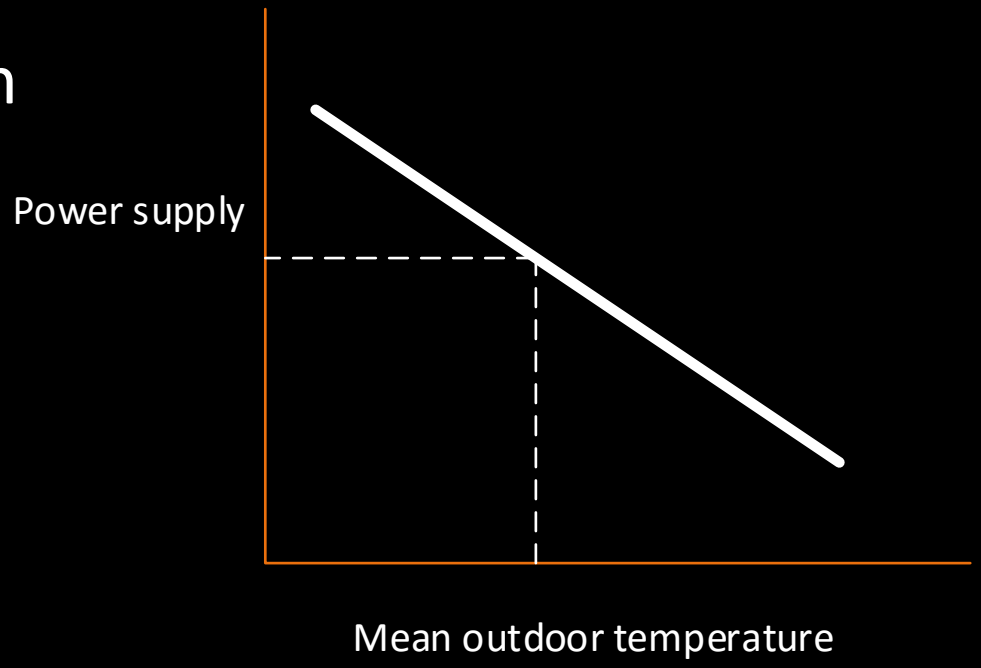
$$A+B+C+D+E=HLC\cdot(T_{in}-T_{out})$$



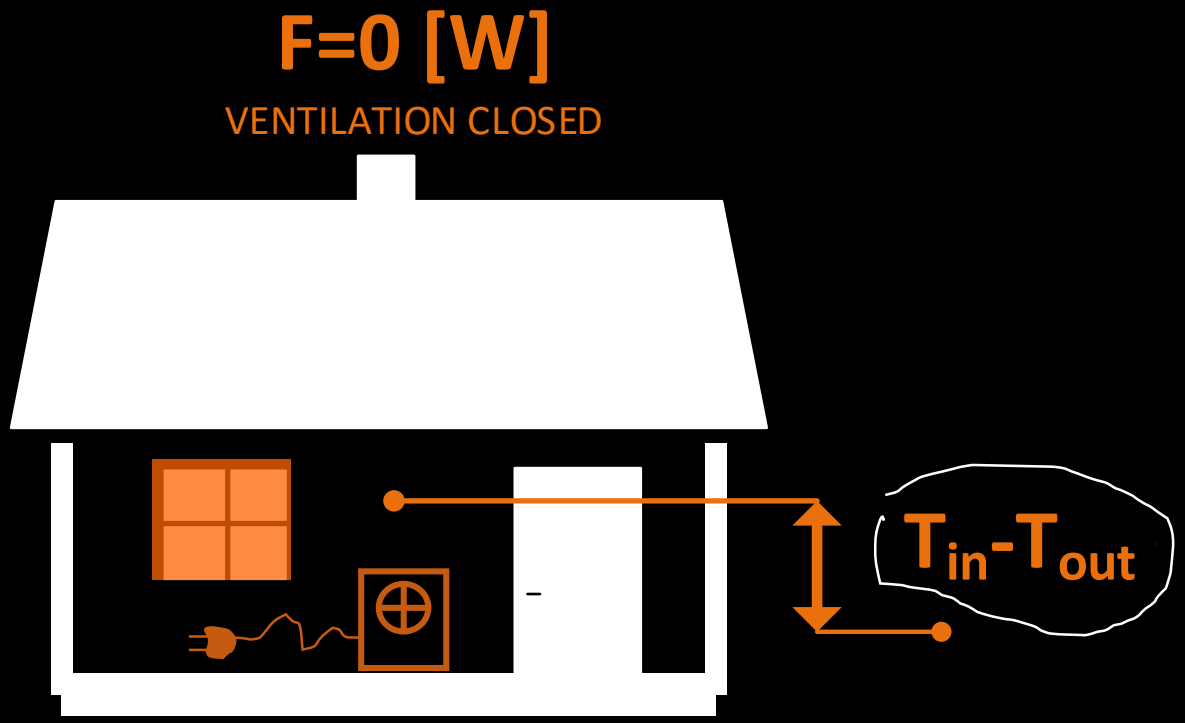
Co-heating test is needed

- when transmission heat losses cannot be quantified by calculations
- to verify calculations & simulations
- as a quality control of building production

$$HLC = U \cdot A \quad \text{or} \quad HLC = A/R$$



During the test



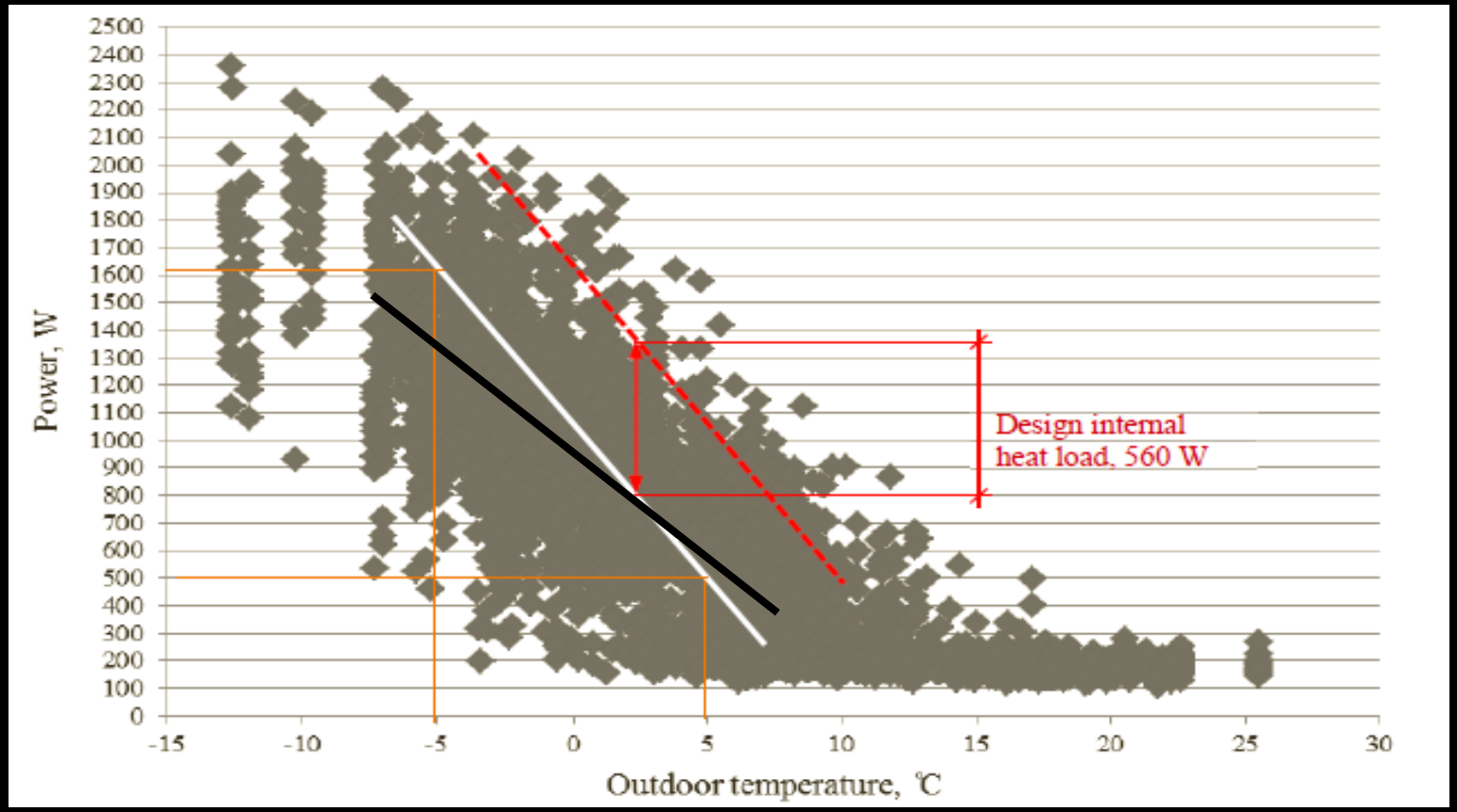
- House is heated to a constant indoor temperature by e.g. electric heater
- Ventilation and other openings are closed
- Internal heat gains are prevented
- Heat supply is measured continuously

Different advices in literature:

T_{in}= 25 °C (77 °F) or
T_{in}-T_{out}~ 15 °C (59 °F)

Reasons for having uninhabited house, no internal heat gains, etc. during the test

Domestic activities significantly affect the power supply to the building



Power supply to 16 identical, newly built single-family houses

Practical issues

- ***HLC*** encloses both transmission and infiltration losses
  - Blower door test and data post-processing are needed

- **Measurement campaign** is too long: 1-3 weeks
  - Building's thermal mass has an impact if the indoor temperature changes
  - The larger the thermal mass, the longer the campaign

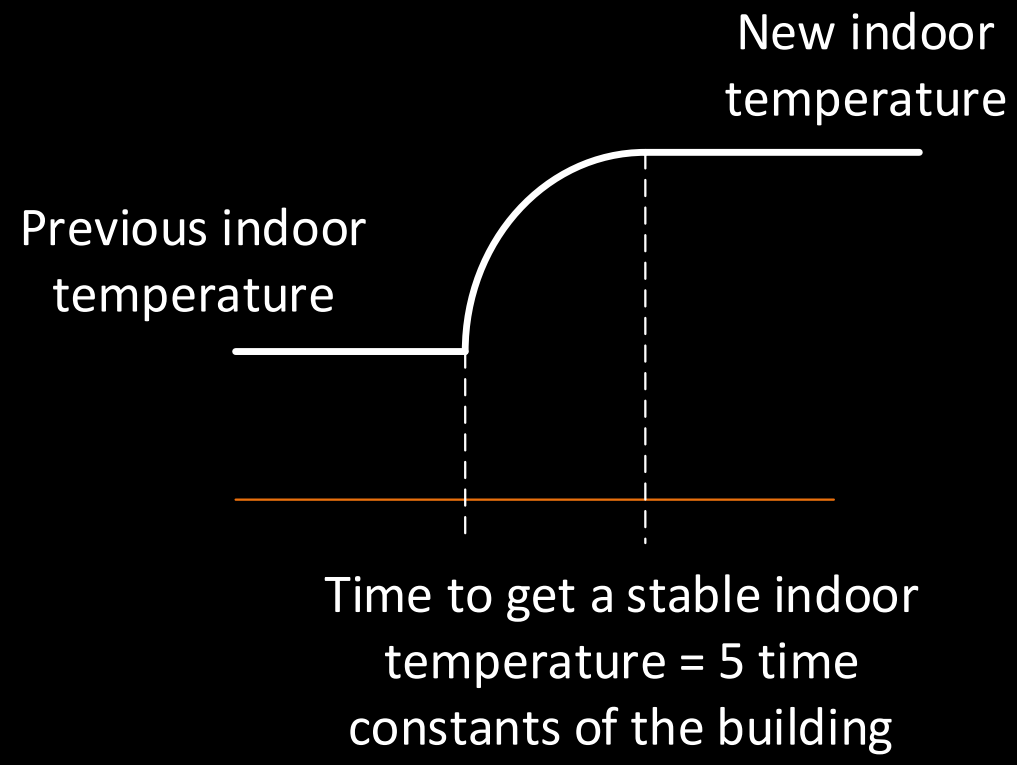
To make the test applicable in praxis

- It has to be simple and short as e.g. blower door test
- It has to be done with simple equipment

Aim of this work – to shorten the test!

Main ideas

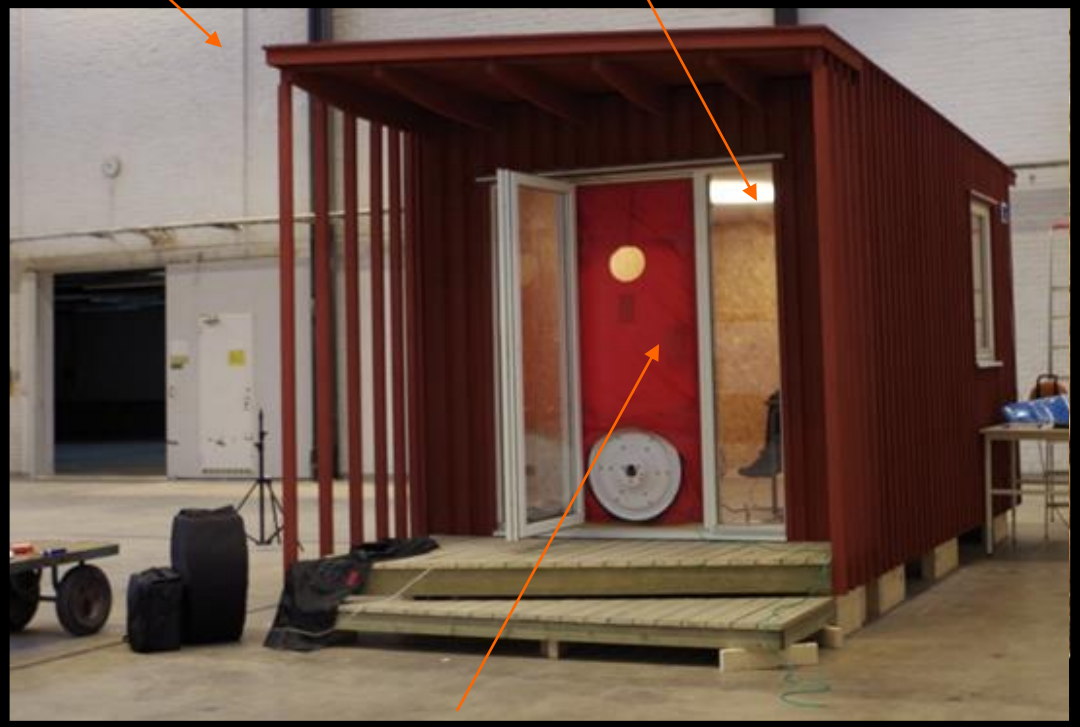
- Do not raise the indoor temperature
- Do measurements during the night-time – avoid solar radiation



Co-heating test under ’ideal’ conditions

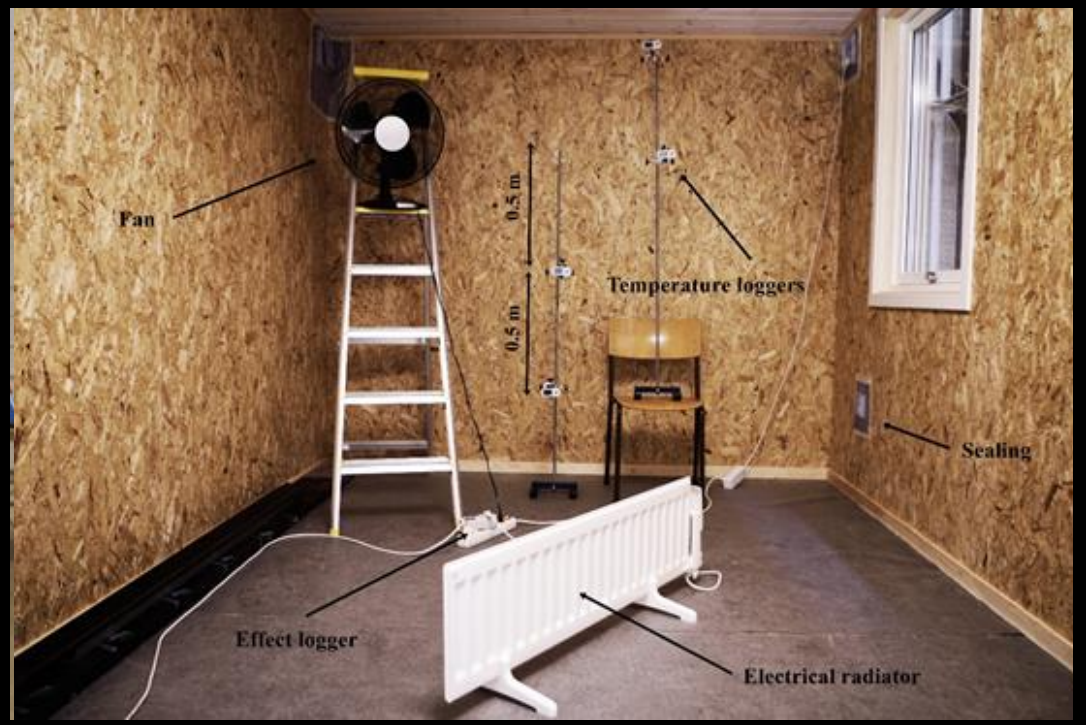
Test hall

Summer cottage (Friggebod)



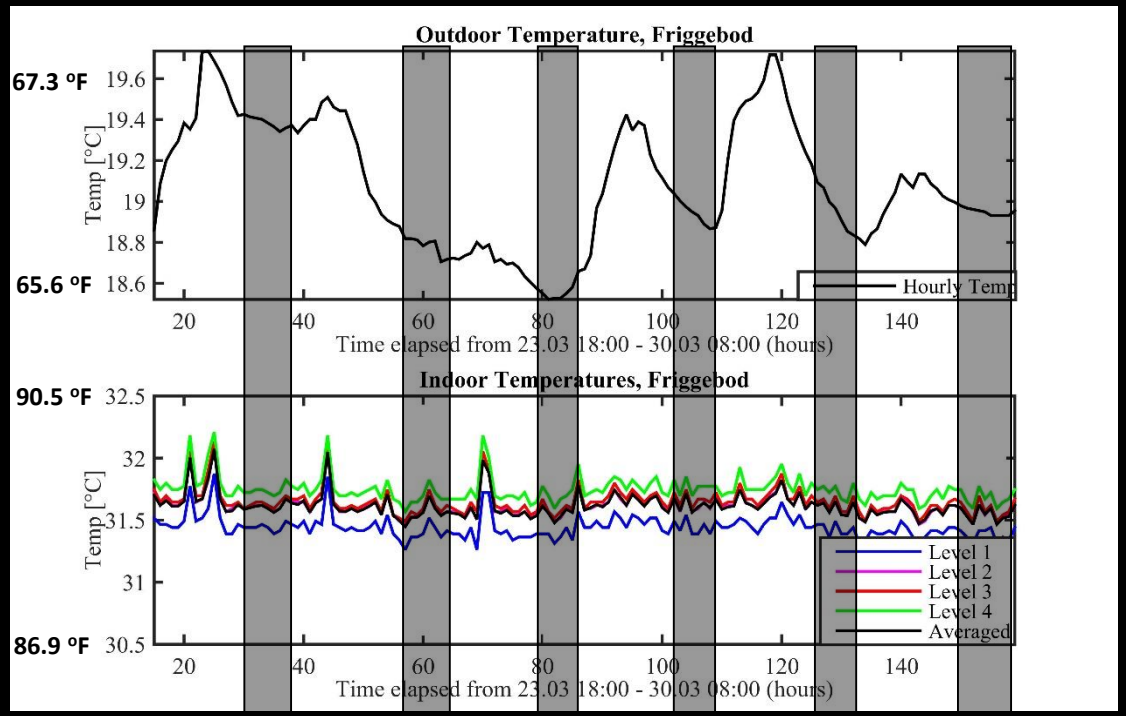
Blower door test

Inside the cottage

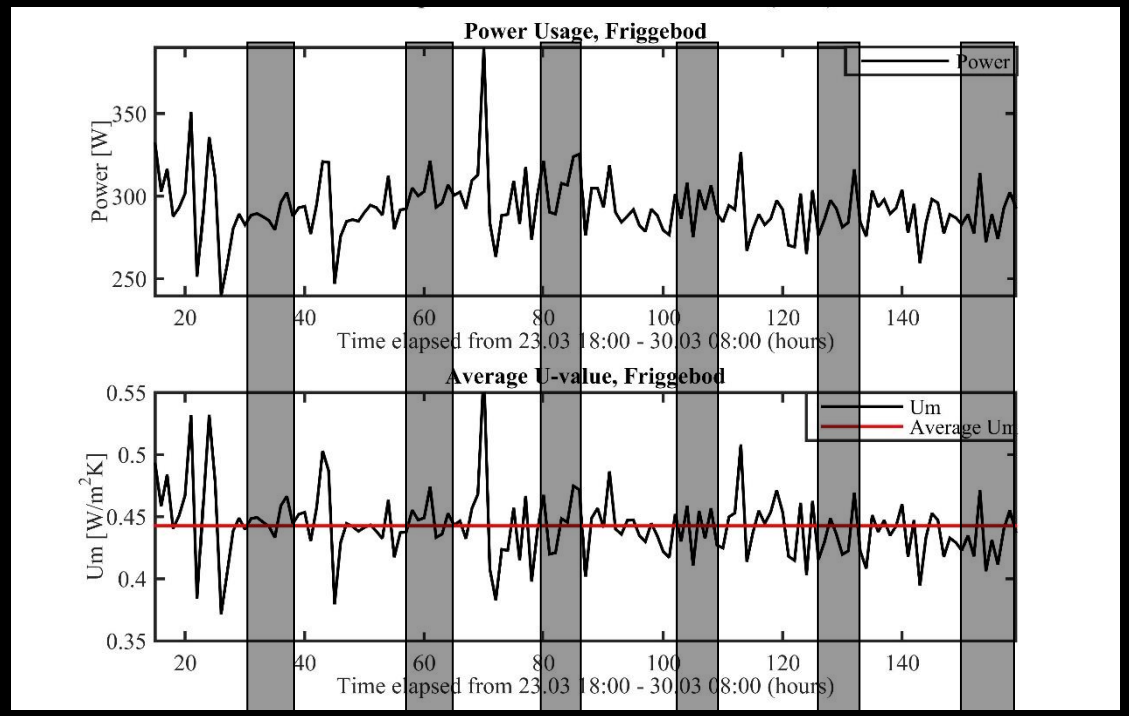


Summer cottage - measurement campaign and results

Outdoor and indoor temperatures



Power supply and mean U-value



Comparison of results: short and long periods

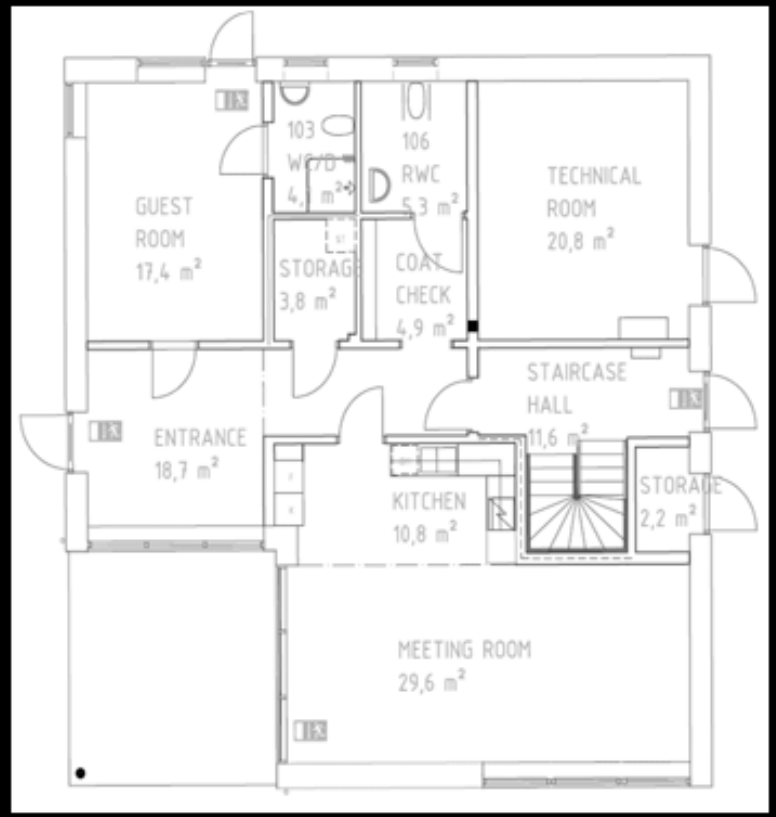
- with the calculated U-value (R-value): 4-6 %
- with the measured average U-value: 0-2 %

Interval	Period of Logging		Average Um [W/m^2·K] [ft^2·°F·h/Btu]	Deviation from the theoretical value [%]	Deviation from the whole period averaged value [%]
	Start	Stop			
Whole period	2015-03-24 09:00	2015-03-30 08:00	0.44 (R-12.9)	-6.4	-
1	2015-03-24 23:00	2015-03-25 09:00	0.45 (R-12.6)	-4.3	2.3
2	2015-03-26 02:00	2015-03-26 09:00	0.45 (R-12.6)	-4.3	2.3
3	2015-03-27 01:00	2015-03-27 06:00	0.44 (R-12.9)	-6.4	0.0
4	2015-03-27 23:00	2015-03-28 05:00	0.44(R-12.9)	-6.4	0.0
5	2015-03-28 23:00	2015-03-29 05:00	0.43(R-13.2)	-8.5	-2.3
6	2015-03-29 23:00	2015-03-30 07:00	0.43 (with fan) (R-13.2)	-8.5 (with fan)	-2.3 (with fan)

Co-heating test under real conditions

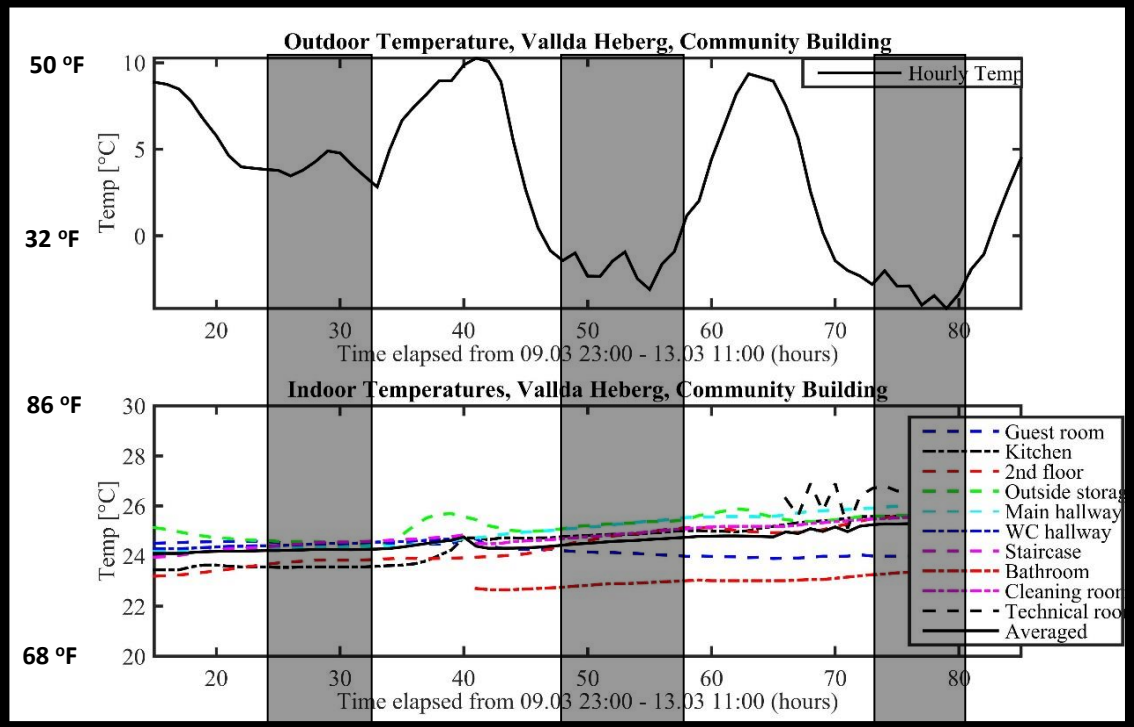
Community building for rent

Complex layout and different ceiling heights



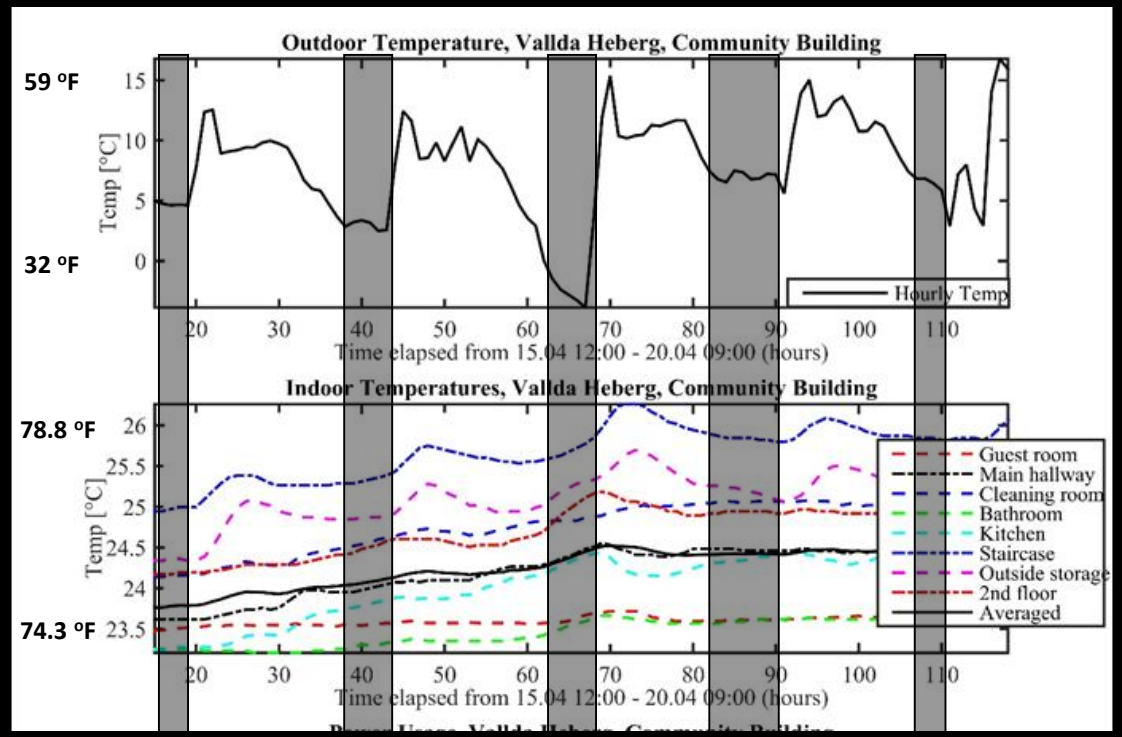
Results for March

Outdoor and indoor temperatures



Results for April

Outdoor and indoor temperatures



Comparison of results: short and long periods

- with the calculated U-value (R-value): 10±1 %
- with the measured average U-value: 12.9±11.2 %

Test 1
March

Interval	Period of Logging		Average Um [W/m^2·K] [ft^2·°F·h/Btu]	Deviation from the theoretical value [%]	Deviation from the whole period averaged value [%]
	Start	Stop			
Whole period	2015-03-10 23:00	2015-03-13 11:00	0.17 (R-33.4)	-10.5	-
1	2015-03-10 23:00	2015-03-11 06:00	0.19 (R-29.9)	-1.6	25.3
2	2015-03-11 22:00	2015-03-12 08:00	0.21 (R-27.0)	12.1	3.5
3	2015-03-12 23:00	2015-03-13 07:00	0.18 (R-31.5)	-7.4	10.0
Periods 1, 2 and 3			0.19±0.02 (R-29.9±0.31)	1.0±10.0	12.9±11.2

Comparison of results: short and long periods

- with the calculated U-value (R-value): 8.6±10.1 %
- with the measured average U-value: -4.6±10.6 %

Test 2
April

Interval	Period of Logging		Average Um [W/m^2·K] [ft^2·°F·h/Btu]	Deviation from the theoretical value [%]	Deviation from the whole period averaged value [%]
	Start	Stop			
Whole period	2015-04-15 12:00	2015-04-20 09:00	0.18 (R-31.5)	-4.2	-
1	2015-04-16 02:00	2015-04-16 07:00	0.20 (R-28.3)	4.2	8.8
2	2015-04-17 02:00	2015-04-17 07:00	0.18 (R-31.5)	-6.3	-2.2
3	2015-04-18 02:00	2015-04-18 07:00	0.18 (R-31.5)	-5.3	-1.1
4	2015-04-18 22:00	2015-04-19 06:00	0.15 (R-37.9	-23.2	-19.8
5	2015-04-19 22:00	2015-04-20 02:00	0.17 (R-33.4)	-12.6	-8.8
Periods 1-5			0.17±0.02 (R-33.4±0.39)	-8.6±10.1	-4.6±10.6

Difference between the measured and calculated U-value (R-value)

For ’ideal ’test conditions (cottage)

- 2-3 % difference

For real test conditions (community building)

- 10±10 % difference

Acceptable – within uncertaintes of the theoretical value

Conclusions

- Suggested modifications of the co-heating test are reasonable.
- The test could be performed with basic equipment composed of a heater, energy and electric power meters, and temperature loggers.
- Blower door test is needed
- The existing heating system could be used if provided by energy meter
- It is sufficient to conduct the test under several night-time periods during cold months.