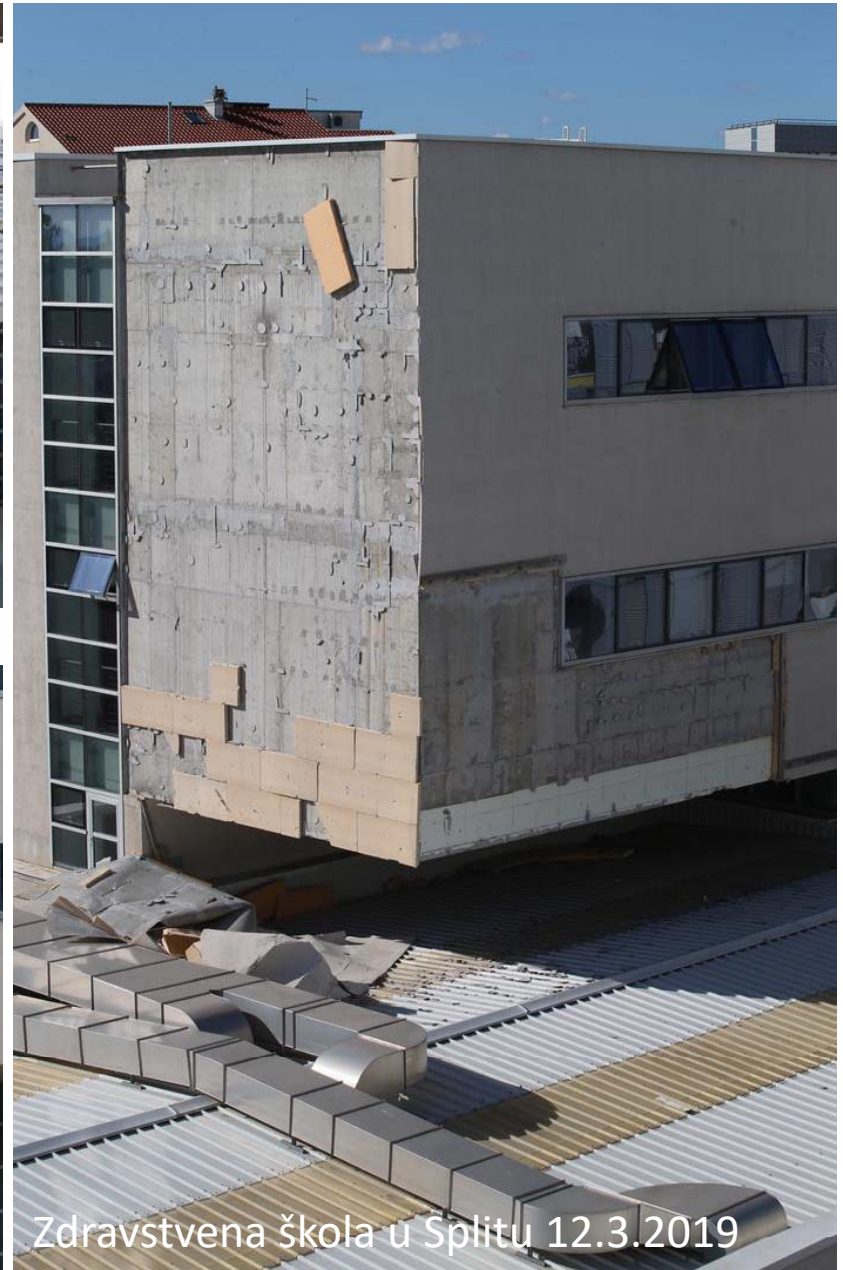


nZEB U PRAKSI

Kontrola kvalitete izvedbe radova

Doc.dr.sc. Bojan Milovanović

izgradimo li ono što
projektiramo?



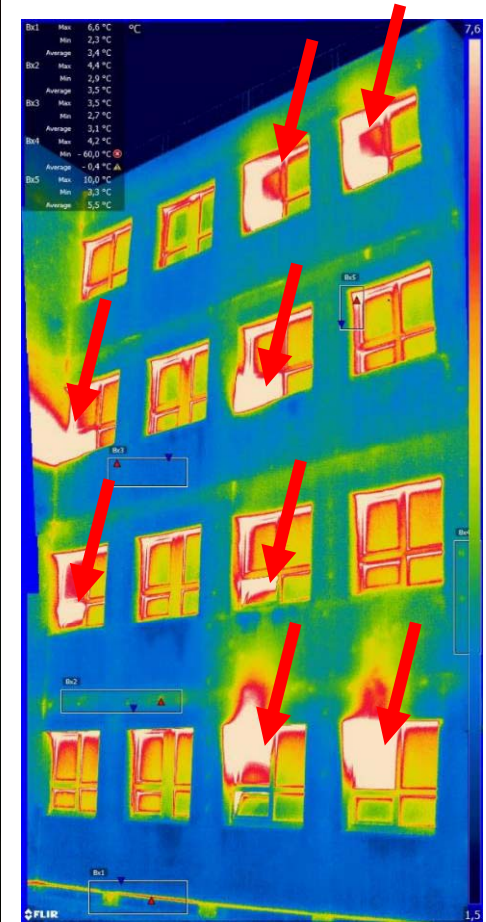
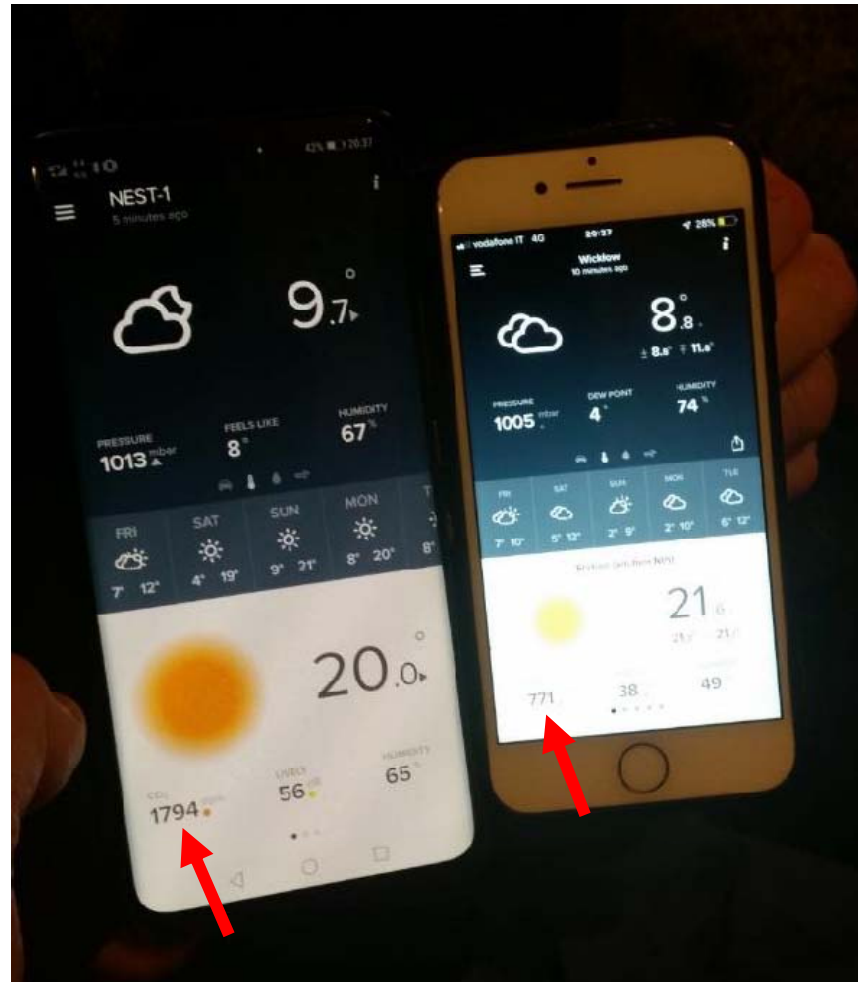
Zdravstvena škola Split 6.2.2020





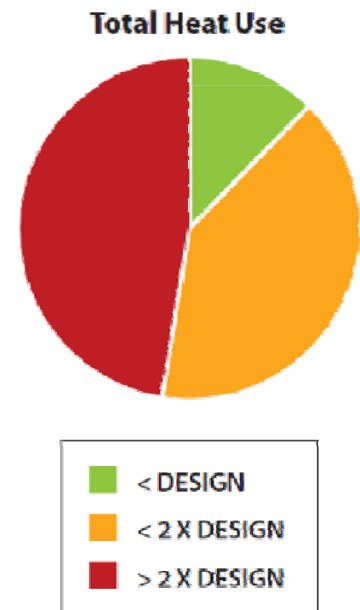
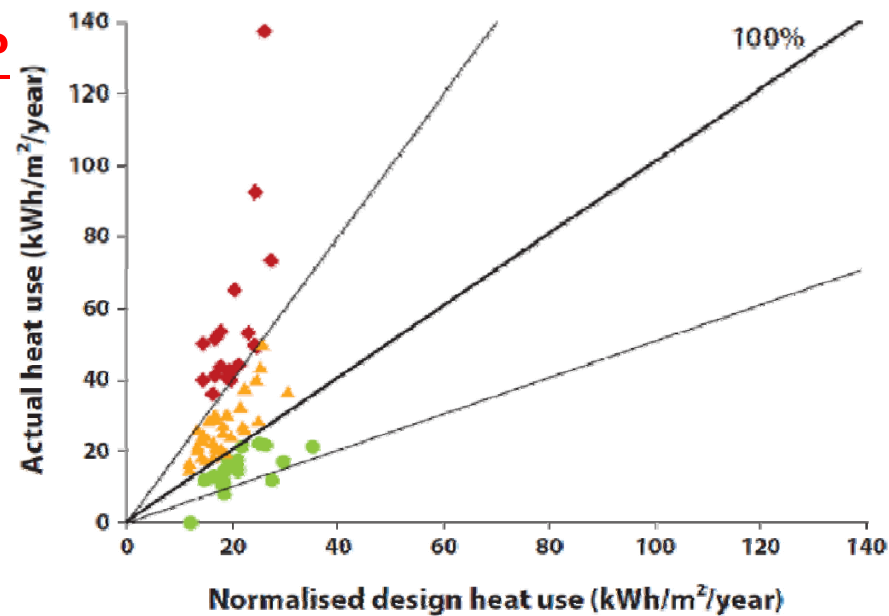
Kvaliteta zraka u prostoru?

MVHR su „pluća“ NZEB-a



Rezultat - Stvarna & projektirana potrošnja

- Usporedba projektirane potrošnje i stvarne potrošnje
- Uzroci:
 - metoda proračuna
 - korištenje
 - **IZVOĐENJE???**



Source: Ghent University

Kako kontrolirati kvalitetu NZEB-a?

1.

Provjera
zrakopropusnosti
ovojnice

Blower Door
test

2.

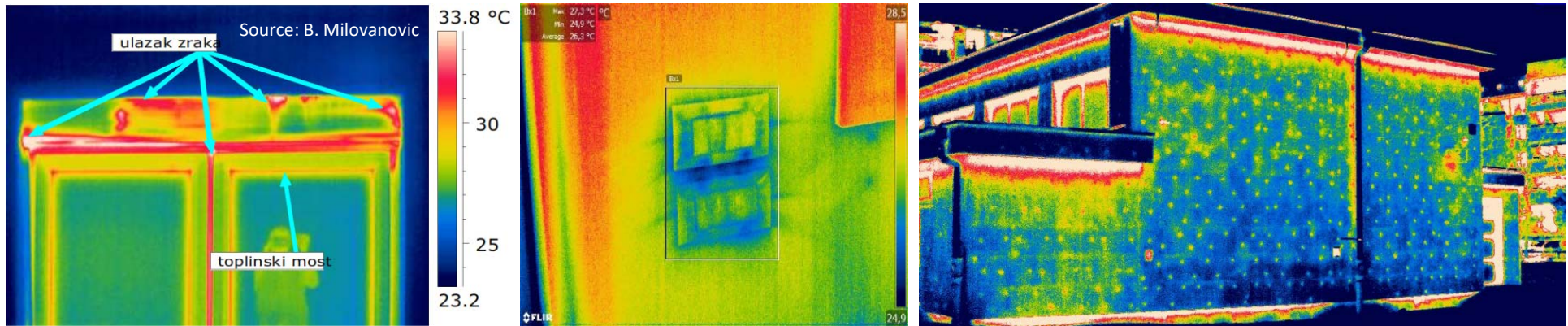
Infracrvena
termografija
za određivanje
mjesta infiltracije
zraka i određivanje
mjesta toplinskih
mostova

3.

Određivanje
koeficijenta
prolaska
topline kroz
prozirne i
neprozirne
elemente

Kako kontrolirati kvalitetu NZEB-a

- Infracrvena termografija

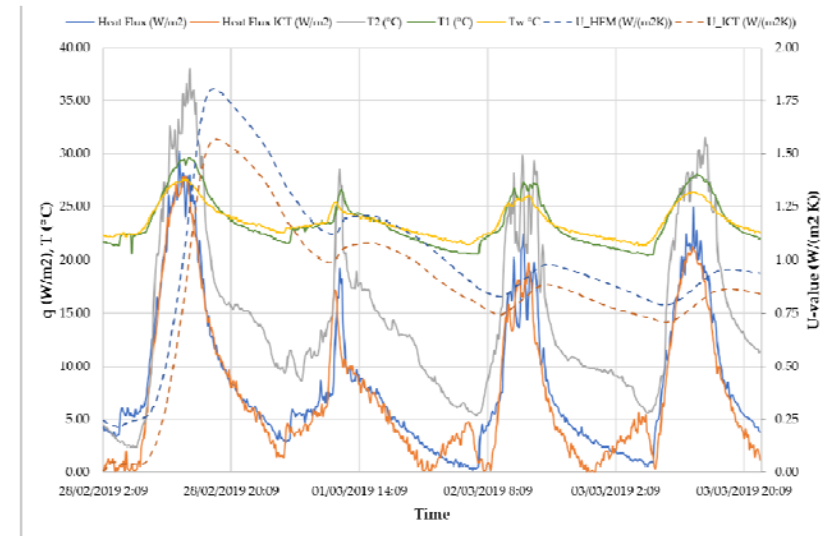


- Blower door



Kako kontrolirati kvalitetu NZEB-a

- Mjerenjem toplinskog toka



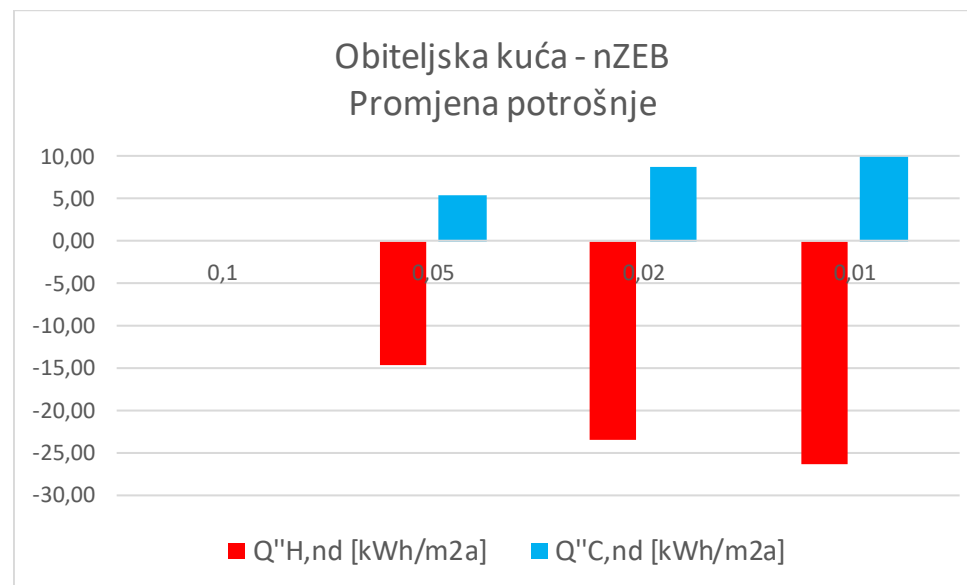
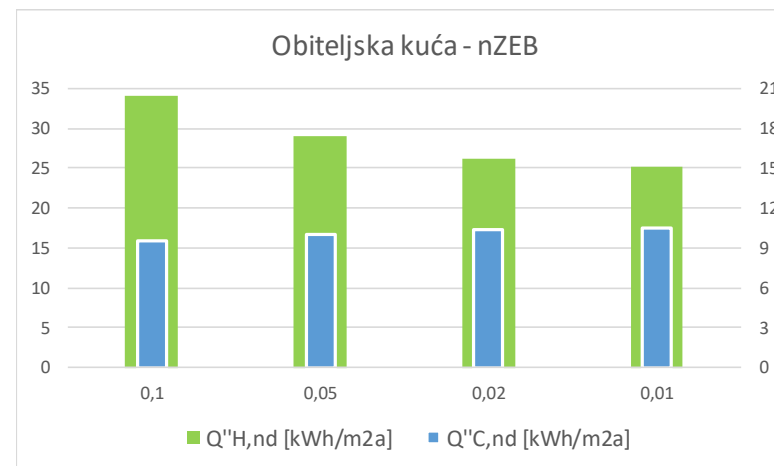
Primjer - utjecaj TM na potrošnju energije

• Kuća u Varaždinu

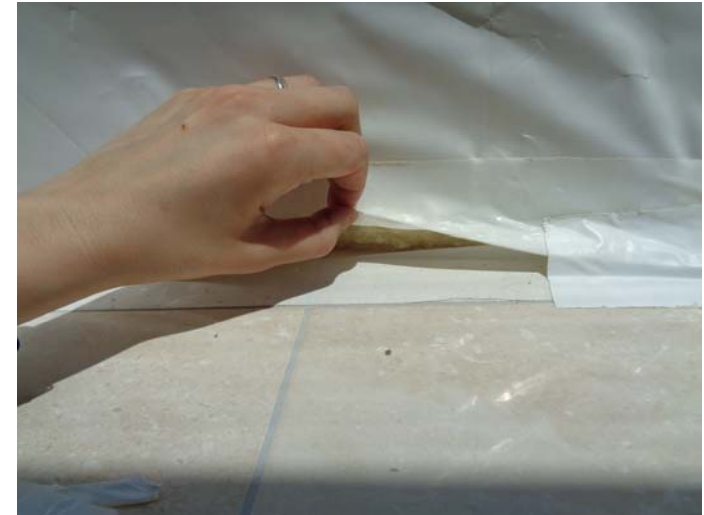
- $A_k = 182,40 \text{ m}^2$
- $A = 407,45 \text{ m}^2$
- $V_e = 570 \text{ m}^3$

Paušalni dodatak

- $\Delta U_{TM} = 0,1 \text{ W/m}^2\text{K}$
- $\Delta U_{TM} = 0,05 \text{ W/m}^2\text{K}$
- $\Delta U_{TM} = 0,02 \text{ W/m}^2\text{K}$
- $\Delta U_{TM} = 0,01 \text{ W/m}^2\text{K}$



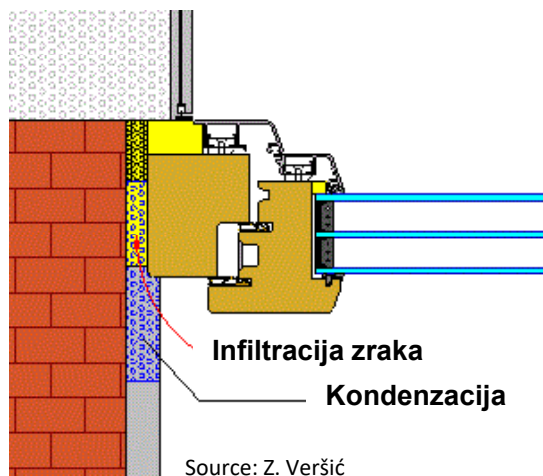
Primjeri zrakopropusne ovojnice





Posljedice

- Loša ugradnja prozora i/ili kutije za rolete može rezultirati vlažnim zidovima i posljedično rastom gljivica i plijesni



Posljedice

- 1) Loša izrada i/ili oblikovanje prozora također može rezultirati infiltracijom vode i/ili kondenzacijom vodene pare te posljedično rastom gljivica i plijesni

Rast gljivica zbog prekida brtve



Zrakopropusni materijali



Unplastered brick or block



Some kinds of OSB Board



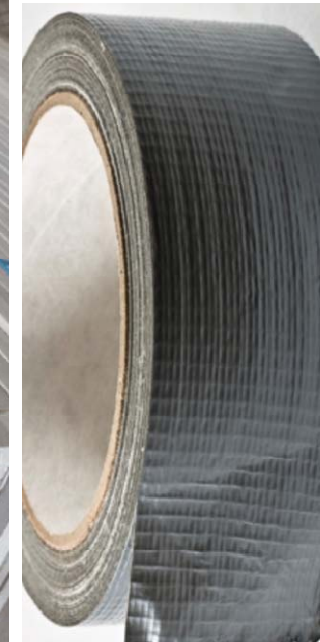
Insulation boards & tongue & groove cladding



Some kinds of spray foam

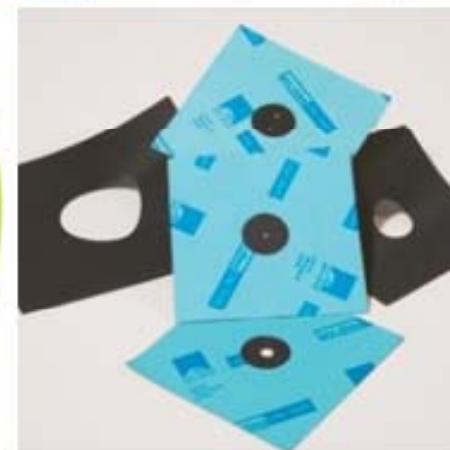


Plasterboard



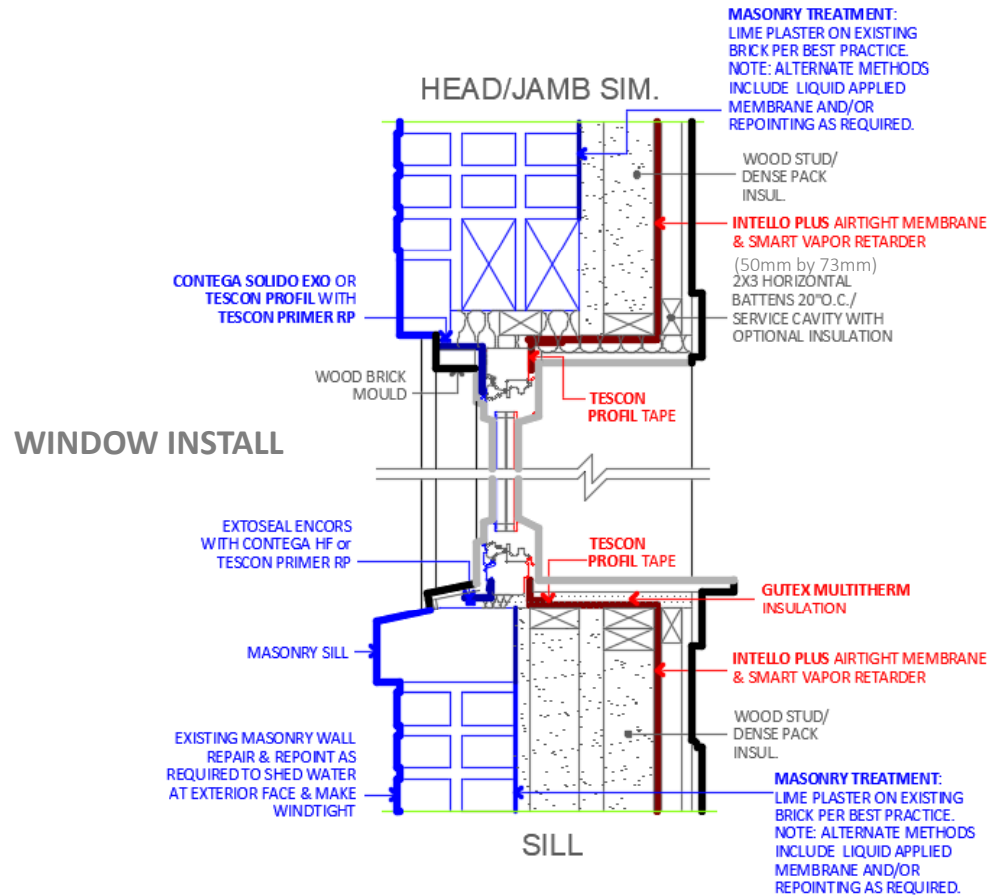
Duct tape

odi kojima JE moguće ostvariti
nepropusnost vanjske ovojnice zgrade



Kako je to u Njemačkoj, Irskoj,...?

Detalji rješavanja kontinuirane toplinske i zrakonepropusne ovojnice (bez TM i infiltracije)



IN RED - INBOARD AIR SEALING COMPONENTS

AIR SEALING COMPONENTS:

MEMBRANE OPTIONS:
DB+
INTELLO PLUS
SOUTEX MENTO 1000
LIQUID APPLIED MEMBRANES

SHEATHING OPTIONS:
OSB
PLYWOOD

CAULKING ADHESIVE OPTIONS:

CONTEGA HF
CONTEGA LINE
TAPE OPTIONS:
TESCON VANA
TESCON PROFIL

CONCRETE

GUTEX MULTITHERM WOOD FIBER INSULATION BOARD

IN BLUE - OUTBOARD AIR SEALING COMPONENTS

OTHER BUILDING COMPONENTS:

MEMBRANE OPTIONS:
SOUTEX MENTO 1000
SOUTEX MENTO PLUS
DA

CONCRETE

BRICK

CAULKING ADHESIVE OPTIONS:

CONTEGA HF

TAPE OPTIONS:

TESCON VANA
TESCON VANA 75, 100, 150 & 200
TESCON PROFIL
CONTEGA EXO
EXTOSEAL ENCOR, FINOC, MAGOV
GUTEX MULTITHERM WOOD FIBER INSULATION BOARD

IN GREYSCALE - OTHER COMPONENTS

DRAWING PROFILE LINE

STRUCTURE

INSULATION OPTIONS:

DENSE PACK: CELLULOSE OR FIBERGLAS

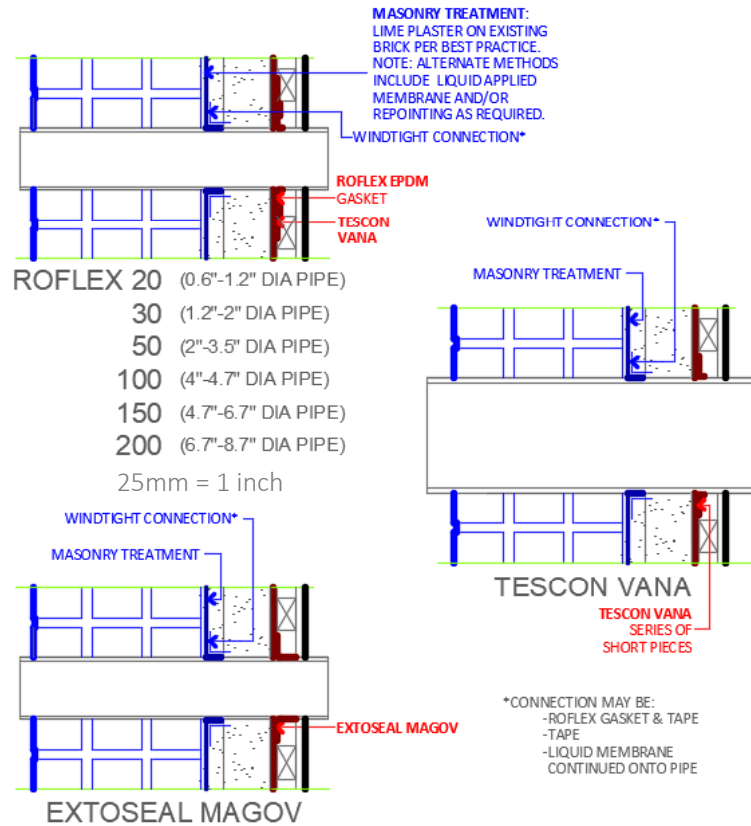
EXISTING FOUNDATIONS

RIGID: GUTEX, MINERAL WOOL OR FIBERGLASS

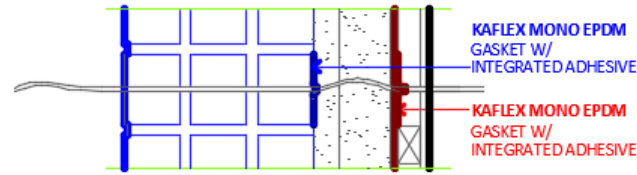
BATT: FIBERGLASS, DENIM, SHEEPS WOOL OR MINERAL WOOL

Source: www.foursevenfive.com

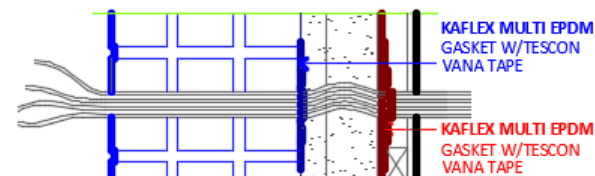
Detalji rješavanja kontinuirane toplinske i zrakonepropusne ovojnice (bez TM i infiltracije)



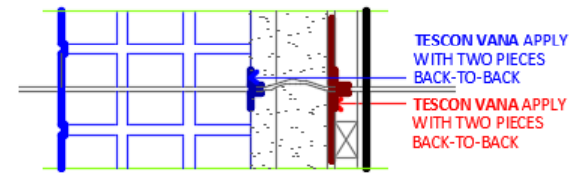
Pipe penetrations



KAFLEX Mono

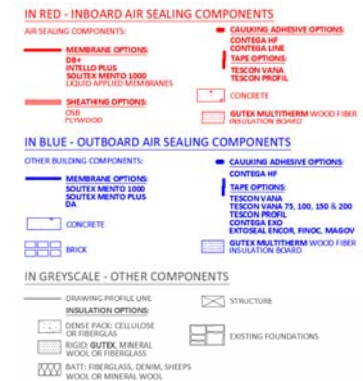


KAFLEX Multi



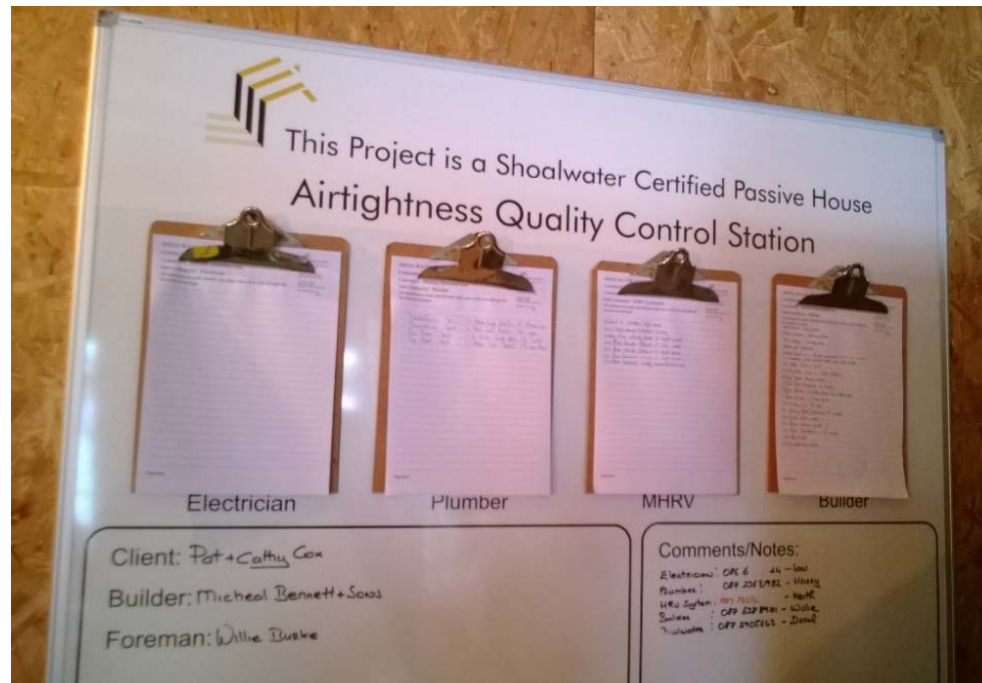
TESCON VANA, PROFIL OR KAFLEX POST

Cable penetrations



Source: www.foursevenfive.com

Communicate Importance of Airtightness



Innovative approach by Irish contractor where all penetrations by different trades are recorded on clipboards to be sealed by project airtightness champion

The German Contractor's Declaration



- New obligatory scheme
- Requires contractors to confirm in writing that the specific minimum energy performance requirements
 - for building envelope components,
 - space heating and hot water generation and distribution systems and
 - newly installed cooling and ventilation systemsare met during the realisation of a renovation measure.
- Infringements lead to fines

Template

Mr/Mrs. Company

.....
(Place, Date)

Contractor's Declaration according to § 26a of the German Energy Saving Ordinance (EnEV) 2009

Building/Invoice as of:
.....

Dear Madam, dear Sir,
Hereby we confirm that the modifications or installations of building components performed by us are in accordance with the requirements of the German Energy Saving Ordinance (EnEV) 2009:

- external insulation layers installed
- external insulation layers renewed
- internal insulation layers installed
- internal insulation layers renewed

This contractor's declaration has to be kept available by you, the building owner, for at least 5 years and has to be provided to the responsible authority on request.

.....
Signature of the company

© Fraunhofer IBP

 **NOTICE** 

This is an Air-tight House

No drilling, chasing, cutting without prior consent from Air-Tight supervisor.

Any damage caused to Air-Tight layer will incur financial penalties to contractor, no exceptions.

Always if in doubt ask the Air-Tight supervisor.

Air-Tight Supervisor on this site

Manufactured in India  UGR 1999 20 20 04 **timbertech homes** INDIA


Frisch luftgedichtet!
Récemment étanchéifié à l'air!
Strato ermetico eseguito!
Just made airtight!

Luftdichtheitsschicht
Strato ermetico all'aria • **Couche d'étanchéité à l'air** • **Airtight layer**




© Ampack AG, Porzschach

Schützen Sie Ihre wertvolle Arbeit!
Protégez votre précieux travail!
Proteggete il vostro prezioso lavoro!
Protect your valuable work!



HOW AIRTIGHT IS YOUR TRADE?



Energy Efficient Airtight Homes

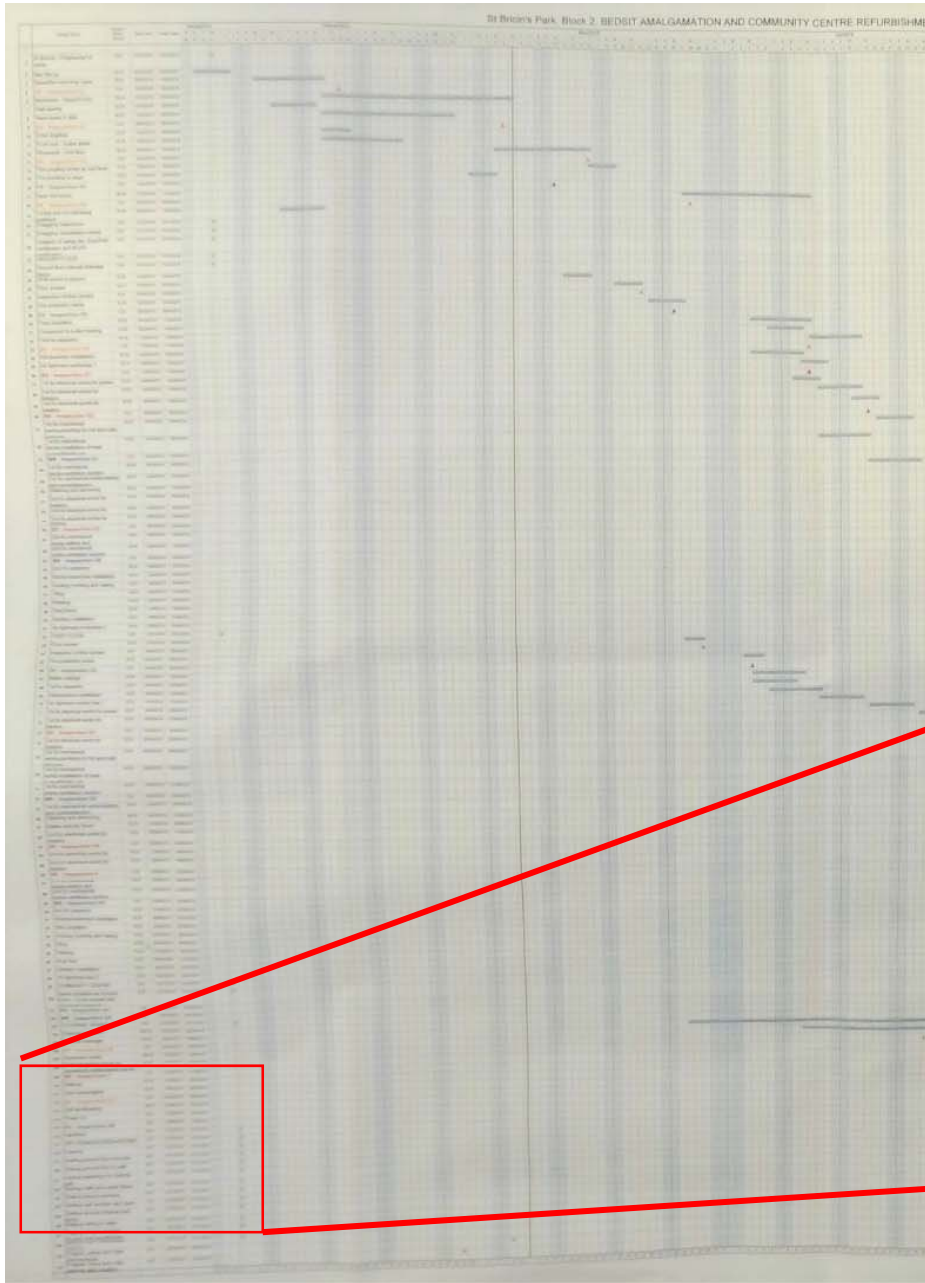
AIRTIGHT BUILDING

NO DRILLING AIRTIGHT CONSTRUCTION **NO CUTTING AIRTIGHT MEMBRANES**

REPORT ALL PENETRATIONS TO SUPERVISOR





100	Same schedule as Ground Floor - To be revised with proposed drawings	8.00	31/01/2018	31/01/2018
101	FS - Inspection 04	0.00	02/05/2018	02/05/2018
102	ME - Inspection 05	0.00	04/07/2018	04/07/2018
103	EXTERNAL WORKS	8.00	31/01/2018	31/01/2018
104	External insulation	304.00	27/03/2018	22/05/2018
105	External drainage	120.00	10/04/2018	30/04/2018
106	SE - Inspection 06	0.00	25/04/2018	25/04/2018
107	Aluminium works	160.00	17/05/2018	13/06/2018
108	External service ducts for gas/electric/cable/telephone etc	64.00	14/06/2018	25/06/2018
109	EE - Inspection 7	0.00	27/06/2018	27/06/2018
110	Railings	120.00	01/05/2018	22/05/2018
111	Hard landscaping	96.00	14/06/2018	29/06/2018
112	SE - Inspection 07	0.00	09/05/2018	09/05/2018
113	Soft landscaping	56.00	27/06/2018	05/07/2018
114	Power on	8.00	21/05/2018	21/05/2018
115	FS - Inspection 05	0.00	13/06/2018	13/06/2018
116	Handover	8.00	31/01/2018	31/01/2018
117	AIR TIGHTNESS BREAKDOWN	8.00	31/01/2018	31/01/2018
118	Flooring	8.00	31/01/2018	31/01/2018
119	Sealing ground floor services	8.00	31/01/2018	31/01/2018
120	Sealing ground floor to wall	8.00	31/01/2018	31/01/2018
121	Internal plastering for internal wall	8.00	31/01/2018	31/01/2018
122	Sealing walls and upper floors	8.00	31/01/2018	31/01/2018
123	Sealing around windows	8.00	31/01/2018	31/01/2018
124	Sealing wall services and opes	8.00	31/01/2018	31/01/2018
125	Sealing around windows and doors	8.00	31/01/2018	31/01/2018
126	Sealing ceiling to walls	8.00	31/01/2018	31/01/2018
127	Sealing around services through roof penetrations	8.00	31/01/2018	31/01/2018
128	IMPORTANT ORDERING DATES	8.00	31/01/2018	31/01/2018
129	Prepare, check and order door/windows	8.00	05/03/2018	05/03/2018
130	Prepare, check and order external wall insulation	8.00	27/02/2018	27/02/2018

... u RH

Molimo Vas da nam dostavite ponudu za termovizijsko snimanje na gore navedenoj građevini a u svemu prema opisu stavke:

B.6. 6. TERMOVIZIJSKO SNIMANJE
Termografsko snimanje zgrade i izrada termografskog izvješća od ovlaštene osobe za termografiju, nakon kompletno završenih radova na ovojnici zgrade.

.600,00 M2

kompl. 1,00

Što trebam raditi?
Kvalitativno,
kvantitativno, koji su
kriteriji...????

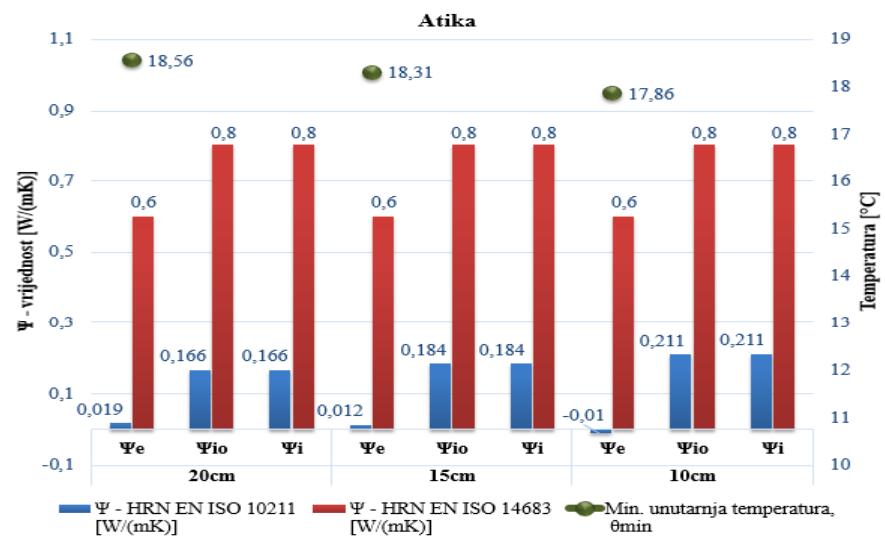
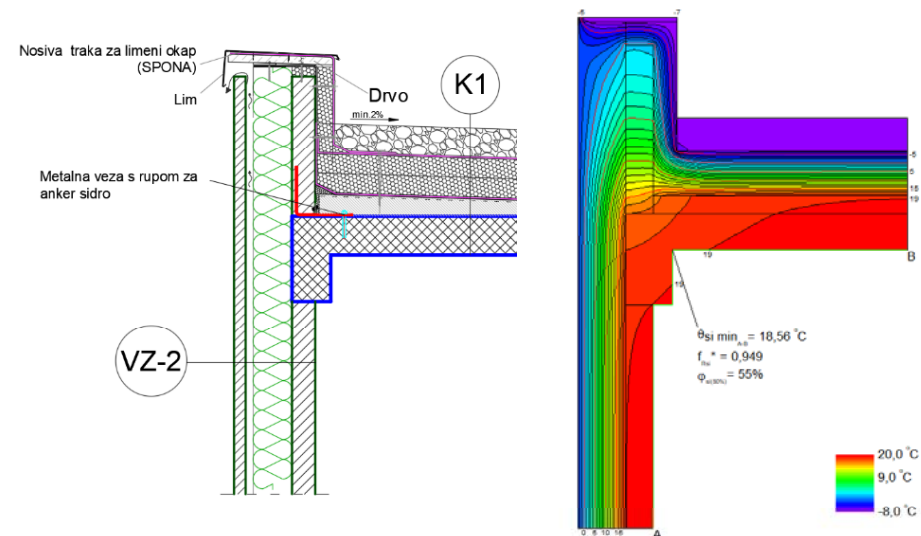
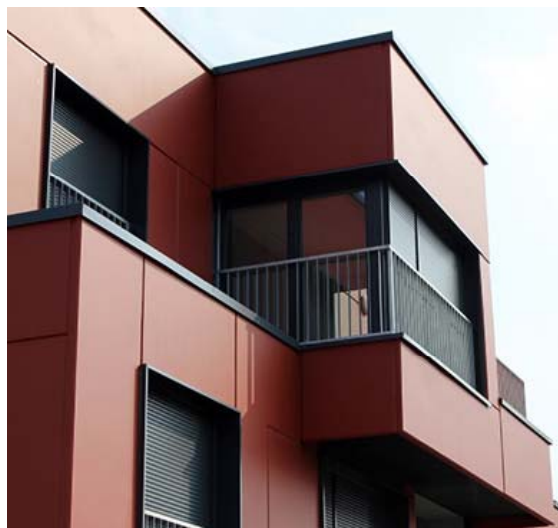
Ovlaštena od
koga? Tko
interpretira?



Znamo li i možemo li i mi u Hrvatskoj?

- mjerenje stvarne potrošnje

Prva ECO-SANDWICH kuća

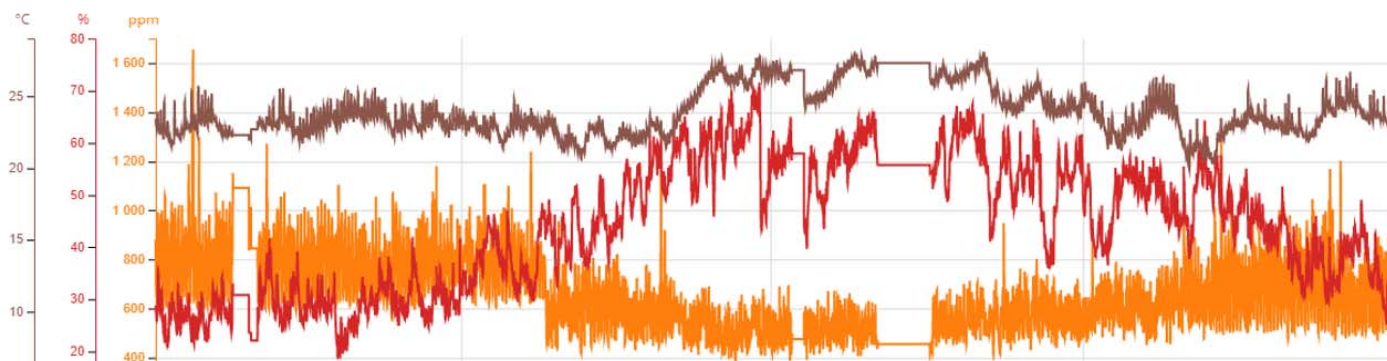


Mjerenja – ESCO Monitor

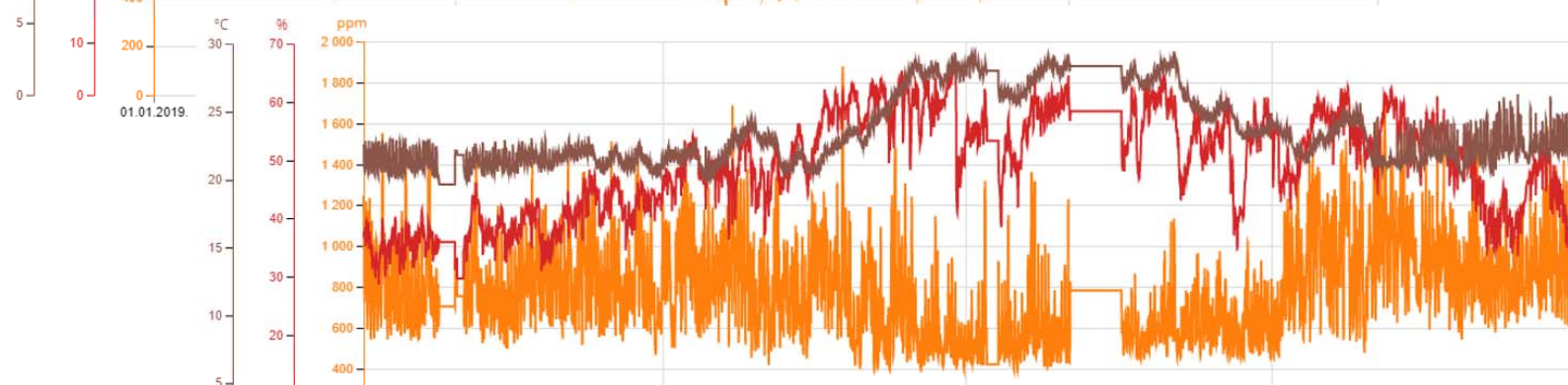
- Mjerenje i analiza **potrošnje energije i parametara ugodnosti** ECO-Sandwich kuće u Koprivnici
 - korištenjem računalno poslovnog sustava **ESCO Monitor**
- mjere se **ukupno 33 parametra** pri čemu se za svaku od tri stambene jedinice provodi daljinsko očitavanje:
 - električne energije (radna energija i maksimalna snaga)
 - potrošnja zemnog plina
 - temperatura na četiri pozicije
 - koncentracije CO₂ na jednoj poziciji
 - relativna vlažnost zraka na jednoj poziciji
- Dodatno se provodi daljinsko očitavanje:
 - električne energije u zajedničkim prostorima zgrade (radna energija i maksimalna snaga)
 - temperatura vanjskog zraka



Temp [°C], RH [%], CO₂ [ppm]

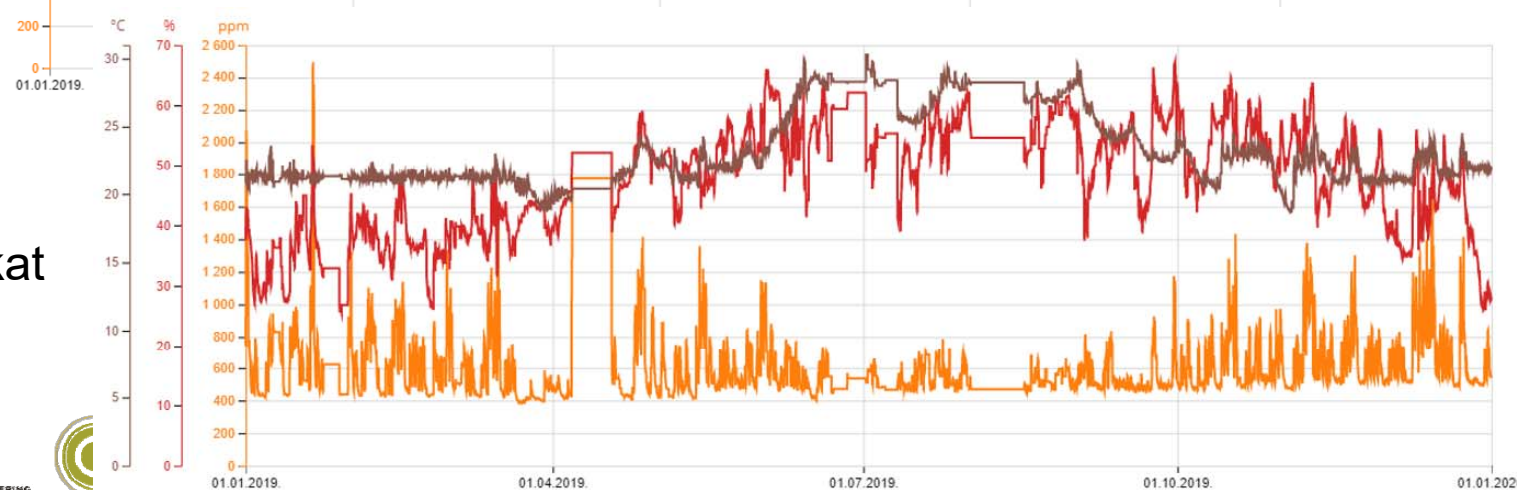


Prizemlje



1. kat

2. kat



Izmjerena potrošnja energije

Period monitoringa: 1. siječanj 2019. – 1. siječanj 2020.

E_{del}	Stan u prizemlju	Stan na 1. katu	Stan na 2. katu	Zajednički prostori (stubište itd.)
Električna energija [kWh]	3113.03	1668.95	1146.57	584.92
Ukupno el. energija [kWh]	5928.55			584.92
	6513.47			
Prirodni plin [kWh]	10896.50	4750.00	8236.50	/
Ukupno prirodni plin [kWh]	23883.00			

$f_p = 1.614$ - za el. energiju

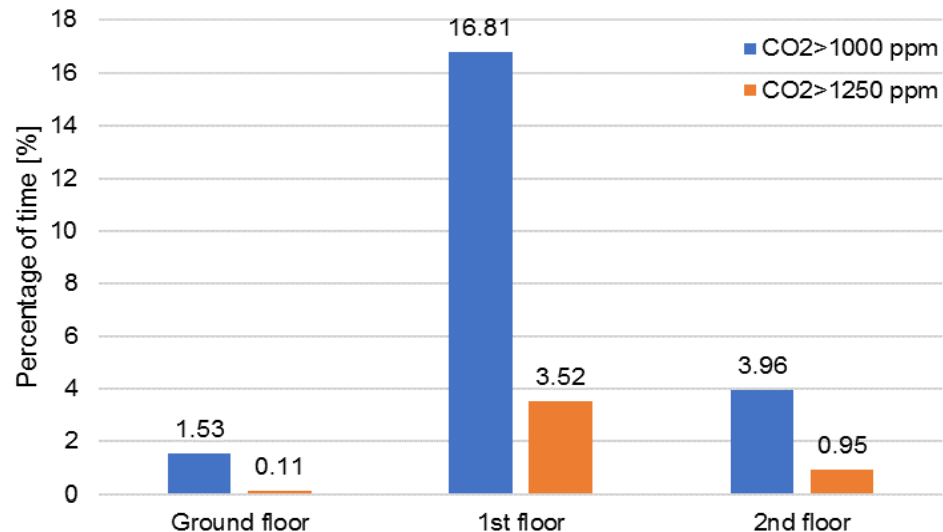
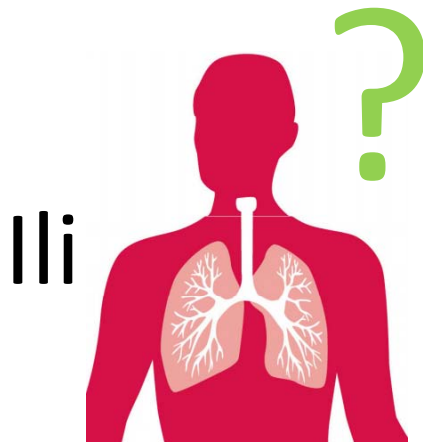
$f_p = 1.095$ - za prirodni plin

$$E_{prim} = 119.77 \text{ kWh/m}^2$$

$$A_k = 306,12 \text{ m}^2$$

* Za cjelokupnu zgradu za svu potrošnju – grijanje, hlađenje, rasvjeta, PTV, kuhanje, ...

- CO₂ koncentracije premašuju limit od 1000 ppm (16.81% vremena) a 1200 ppm (3.52%)



The European standard also classifies the **indoor air quality in four "classes"**, from IDA4 - low air quality buildings to IDA1 - high air quality buildings.

CO₂ concentration in indoor air provides generally a good indication of effective ventilation, but not of absolute air quality.

NIOSH considers indoor levels of CO₂ exceeding **1,000 ppm** a marker suggesting inadequate ventilation.

ASHRAE recommends CO₂ levels not exceeding **700 ppm above outdoor levels**.

The UK standards for schools set the limit to **1,500 ppm in classrooms**.

EU Typical CO₂ indoor levels range is **600 to 1000 ppm above outdoor ambient levels**.

Indoor Air Quality (EN13779)

Cat.	Quality	CO ₂ above outdoor air (ppm)	Default value (ppm)	Fresh Air Rate (l/s/person)
IDA 1	High	≤ 400	350	> 15
IDA 2	Medium	400 - 600	500	10 - 15
IDA 3	Moderate	600 - 1000	800	6 - 10
IDA 4	Low	> 1000	1200	< 6

Outdoor Air concentration levels according to EN13779

Air Quality	Concentration Levels					O D A
	CO ₂ ppm	CO mg/m ³	NO ₂ µg /m ³	SO ₂ µg /m ³	PM10 µg/m ³	
Rural areas	350	<1	5-35	<5	<20	1
Small Towns	400	1-3	15-40	5-15	10-30	2
City Centres	450	2-6	30-80	10-50	20-50	3

One of the most significant problems of the construction market in Croatia is the lack of competences on NZEB.
(all participants in construction projects)





www.fit-to-nzeb.com



Network for Using BIM
to Increase Energy Performance

www.net-ubiep.eu



Education for zero energy buildings using Building Information Modelling





Beplatne radionice!

- Validirajte naše trening materijale!
- Pomozite nam da ih poboljšamo!
- Naučite o BIM-u



Sustavno obrazovanje i umjereni oprema!

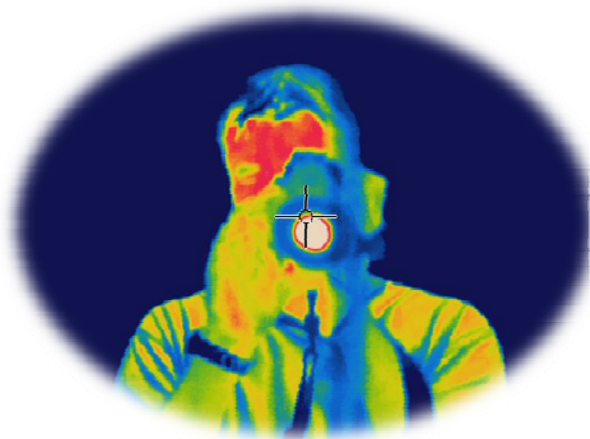


KVALITETA JE VAŽNA!



SVEUČILIŠTE U ZAGREBU
GRAĐEVINSKI FAKULTET
UNIVERSITY OF ZAGREB
FACULTY OF CIVIL ENGINEERING

Hvala na pažnji!



Bojan Milovanović

bmilovanovic@grad.hr

Pratite nas...