Croatian building stock renovation: are we reaching the goal?

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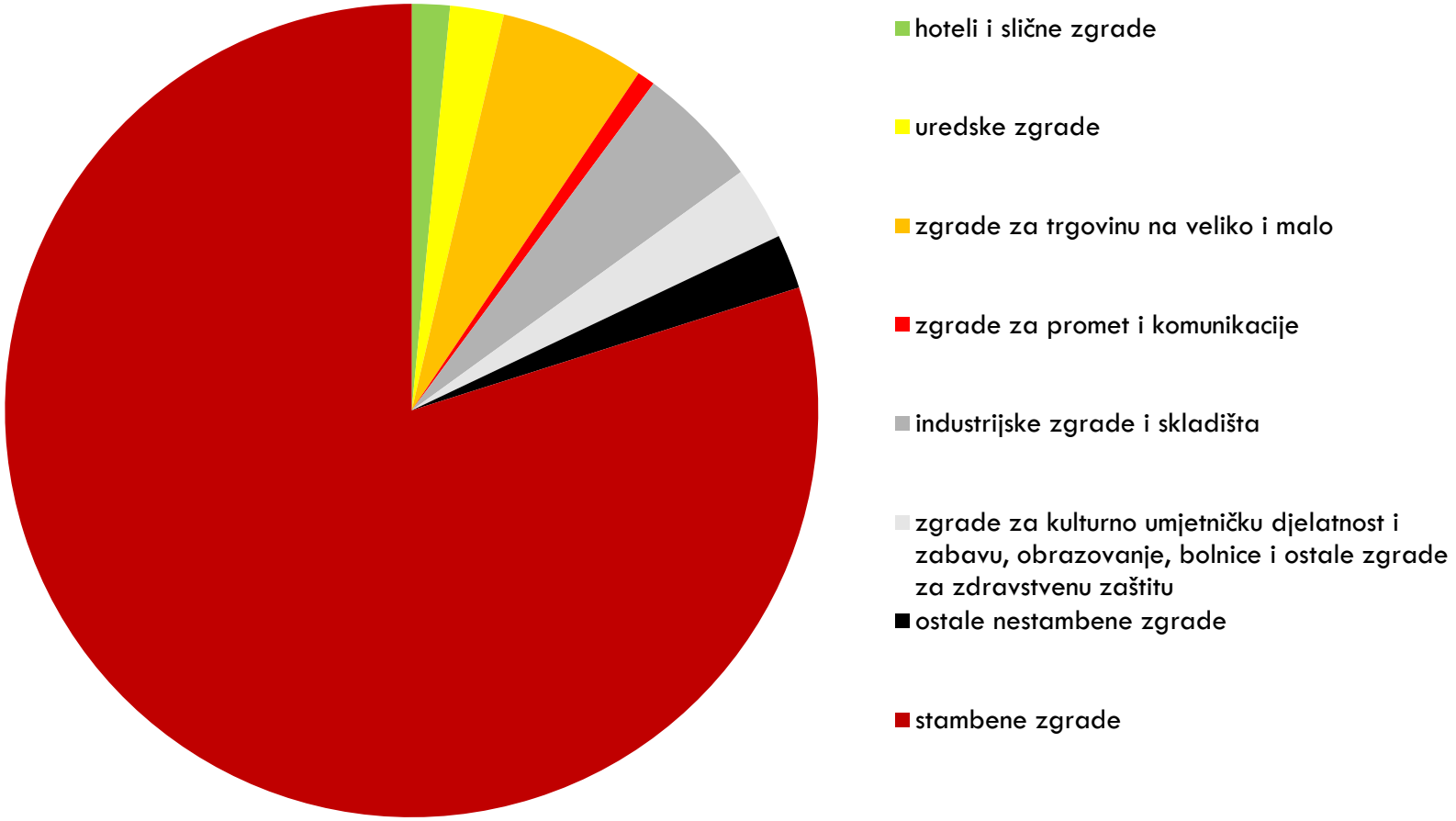
National building stock decomposition by building use



Building stock change 2011 - 2018

building stock in 2011

198.133.193 m²

building registry legally grounded in 2021.

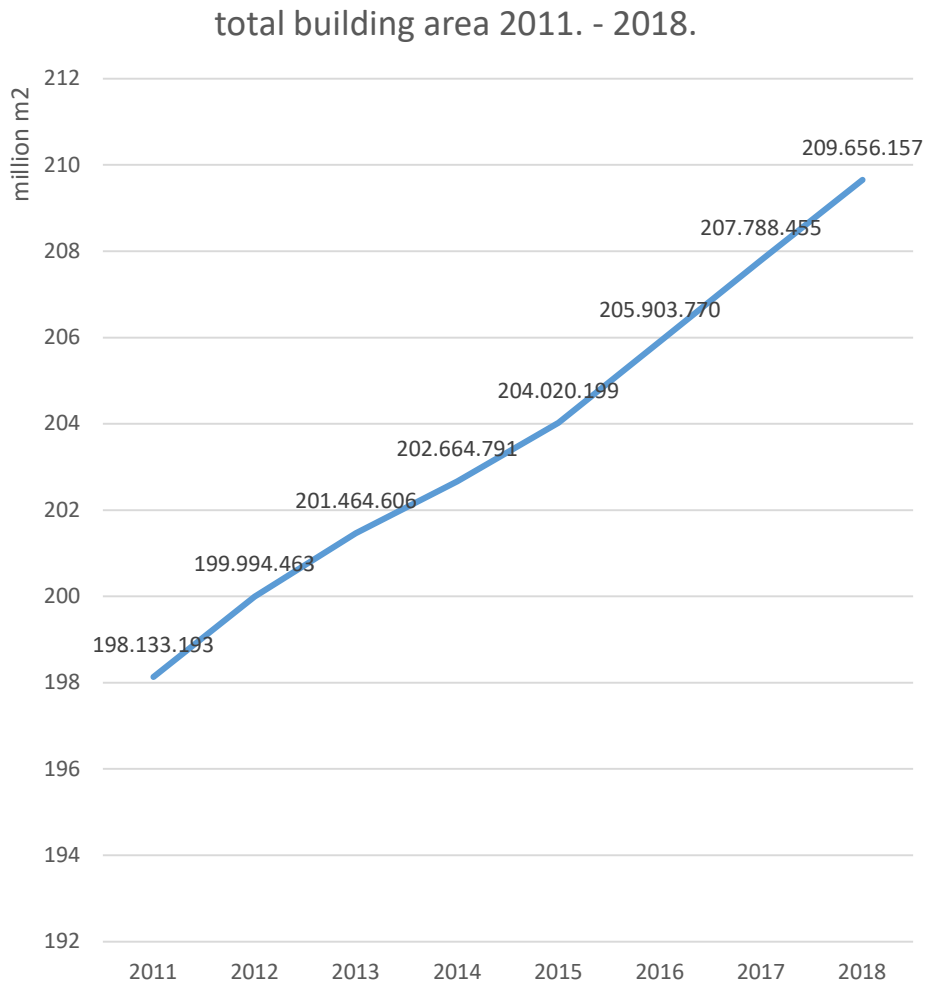
estimate based on census data amended by:

- issued building permits

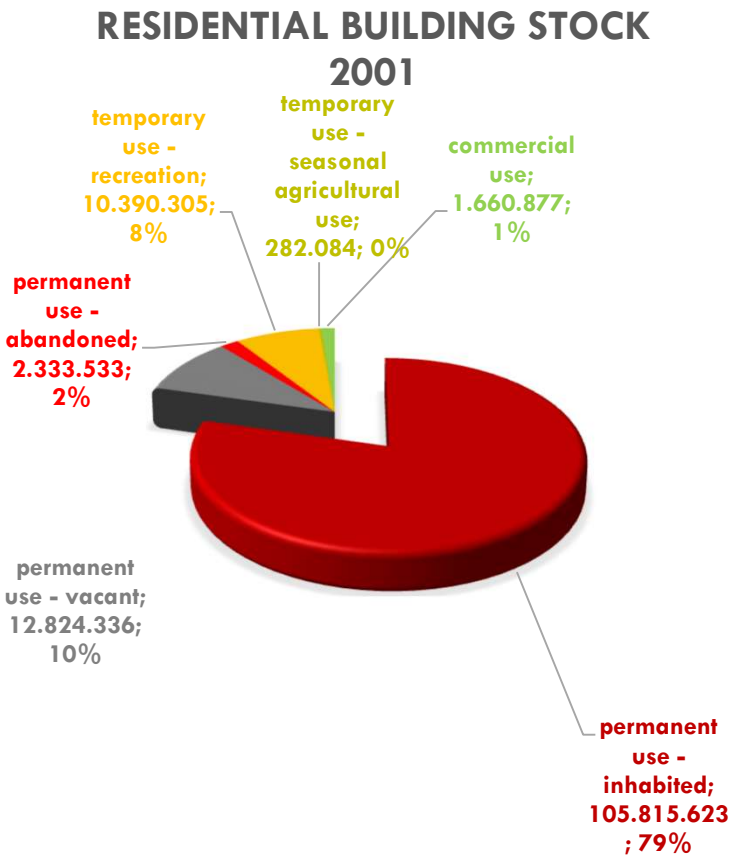
- completed buildings survey data

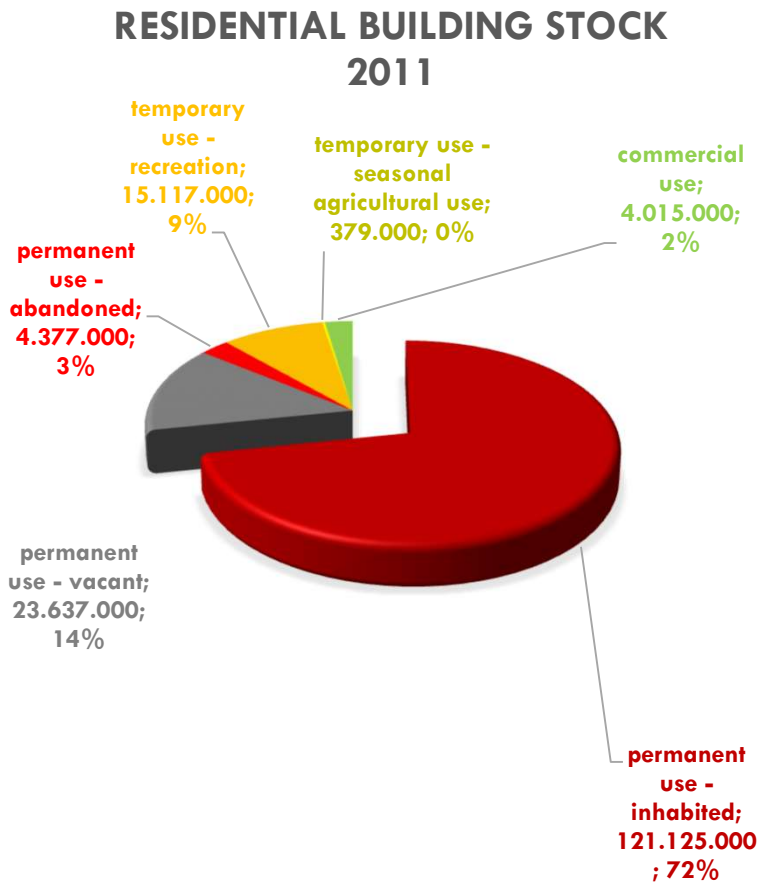
- demolished buildings data

considering the inhabited/abandoned residential building ratio



Residential building stock use comparison 2001 - 2011



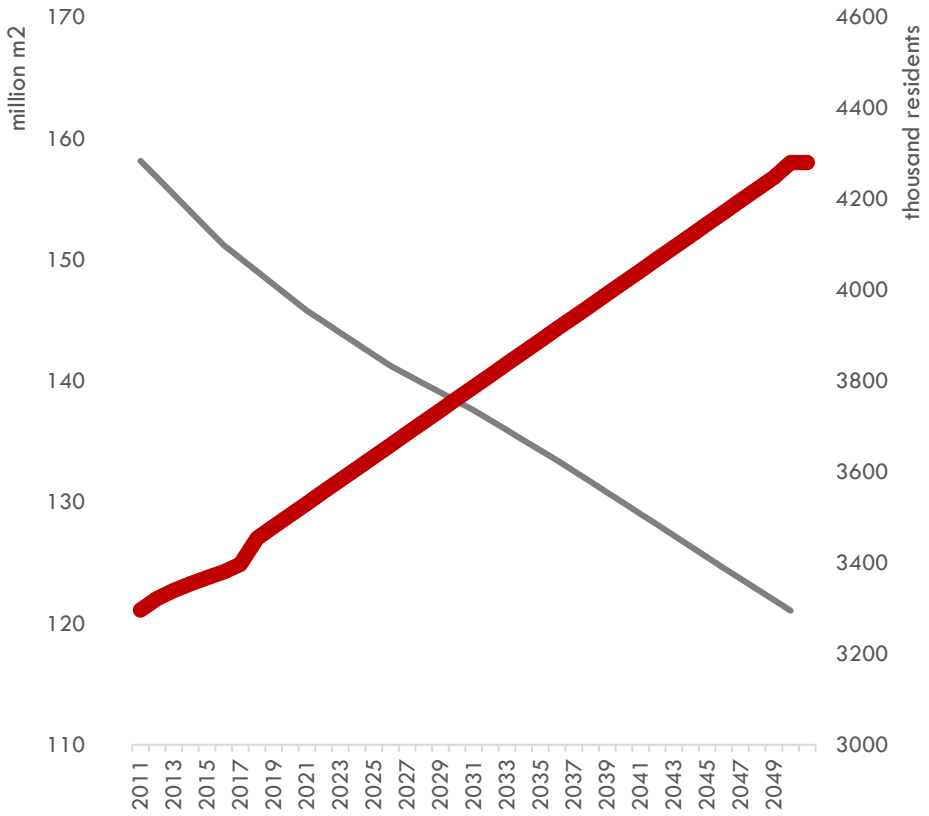


Residential building stock projections until 2050 based on moderate demographic scenario

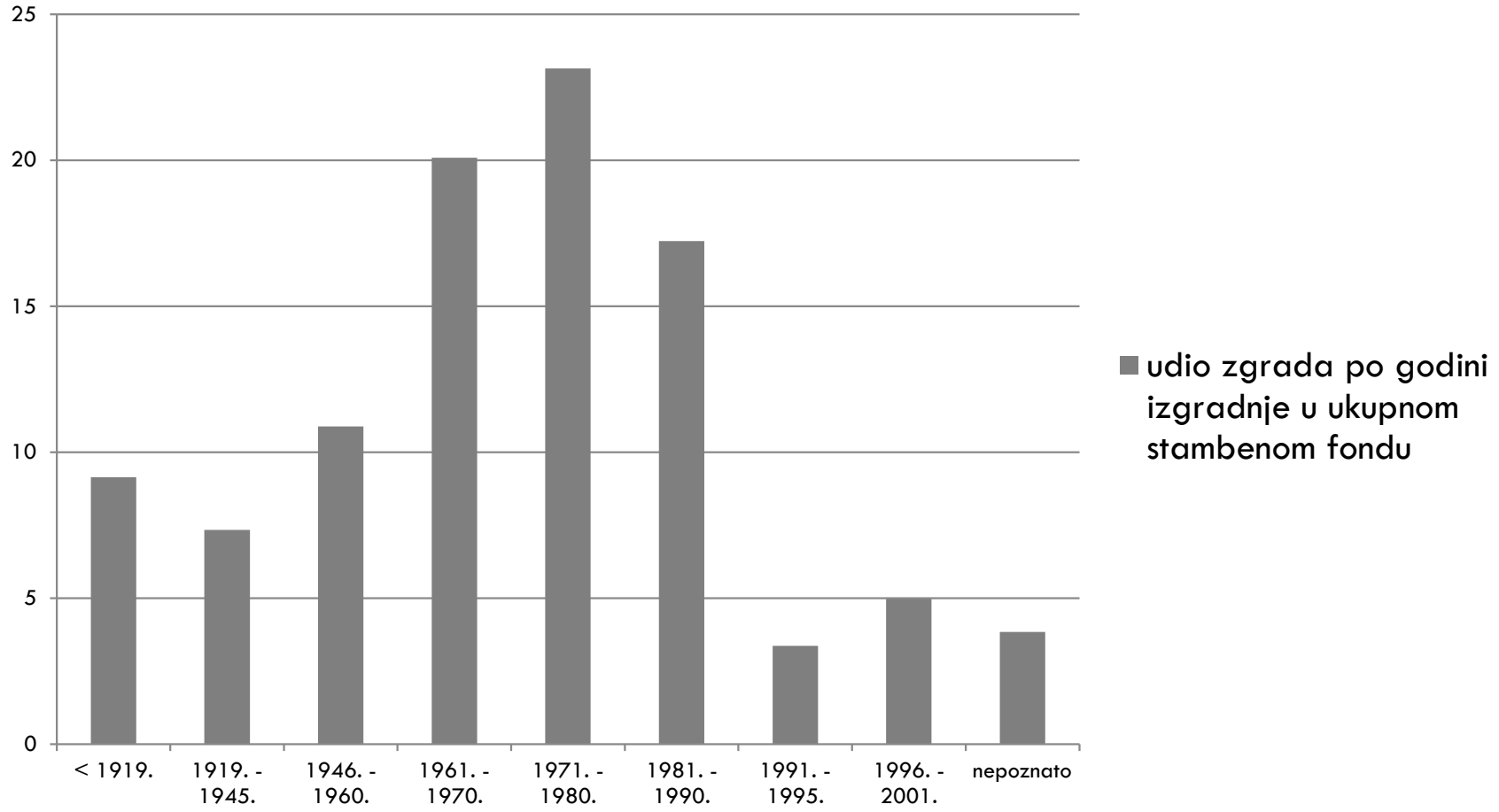
average residential area per resident

EU 28 2019	42,6 m^2
Croatia 2011	30,0 m^2
Croatia 2050	48,0 m^2

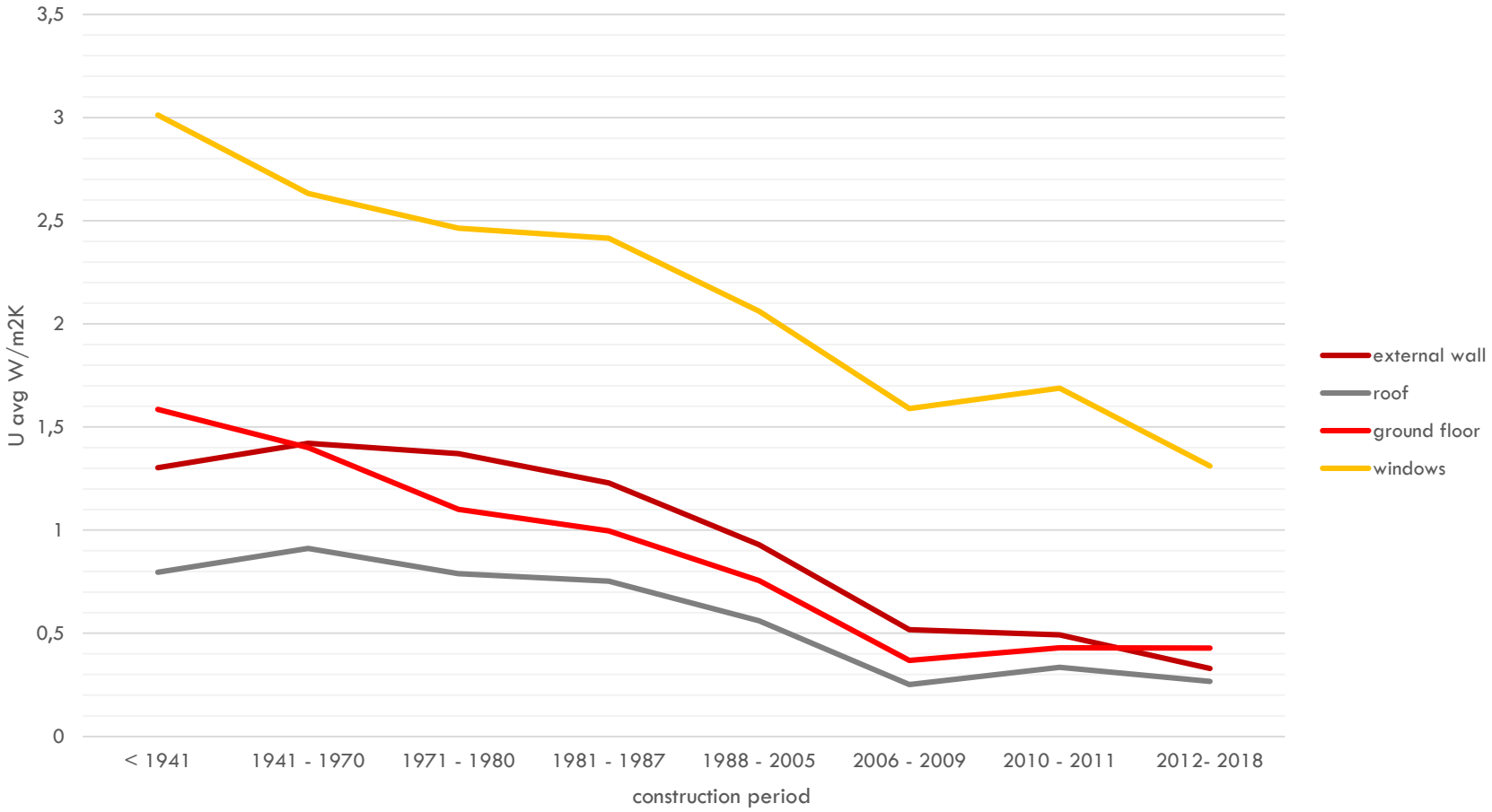
projection of building stock area and population



National building stock decomposition by construction period



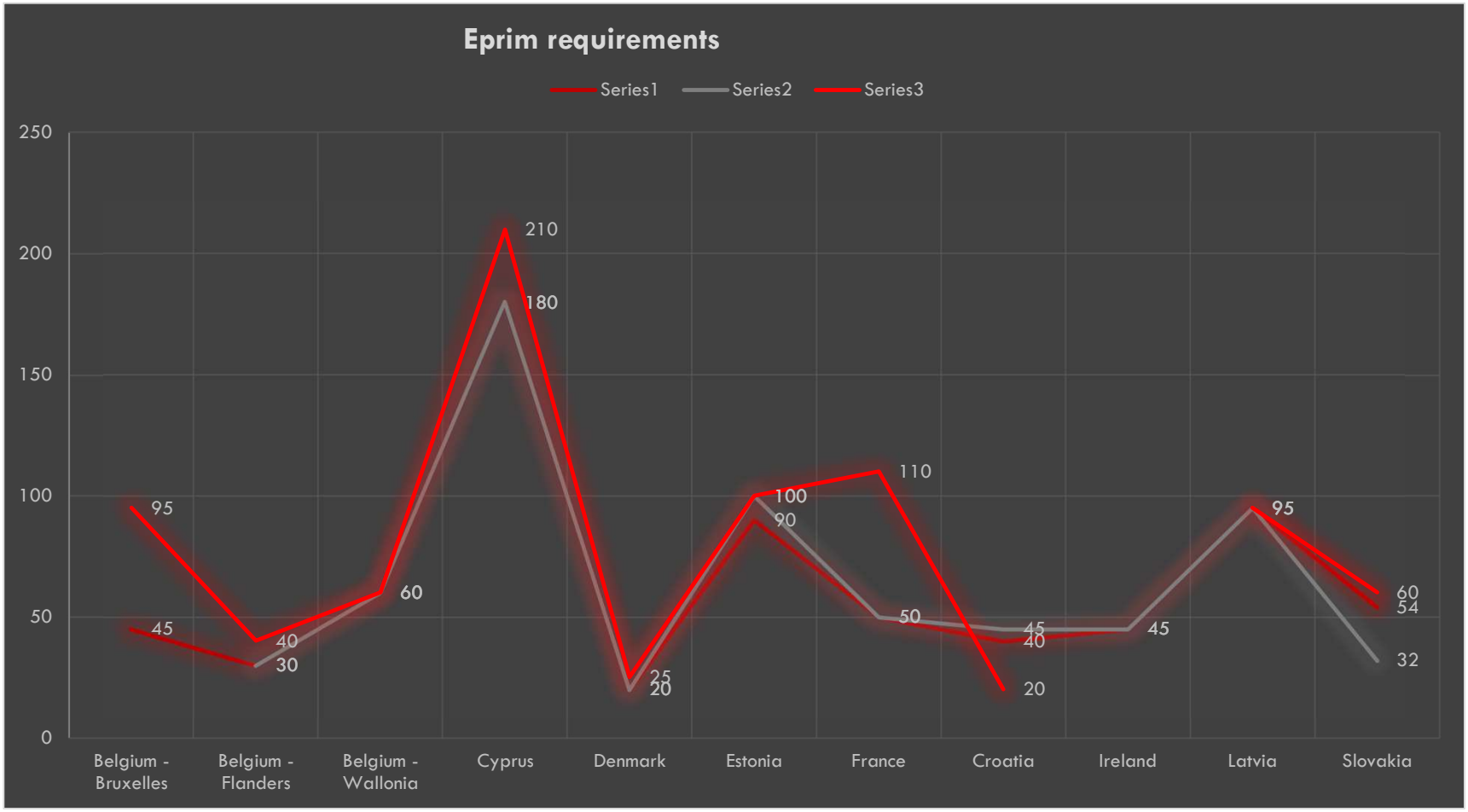
External envelope characteristics by construction period



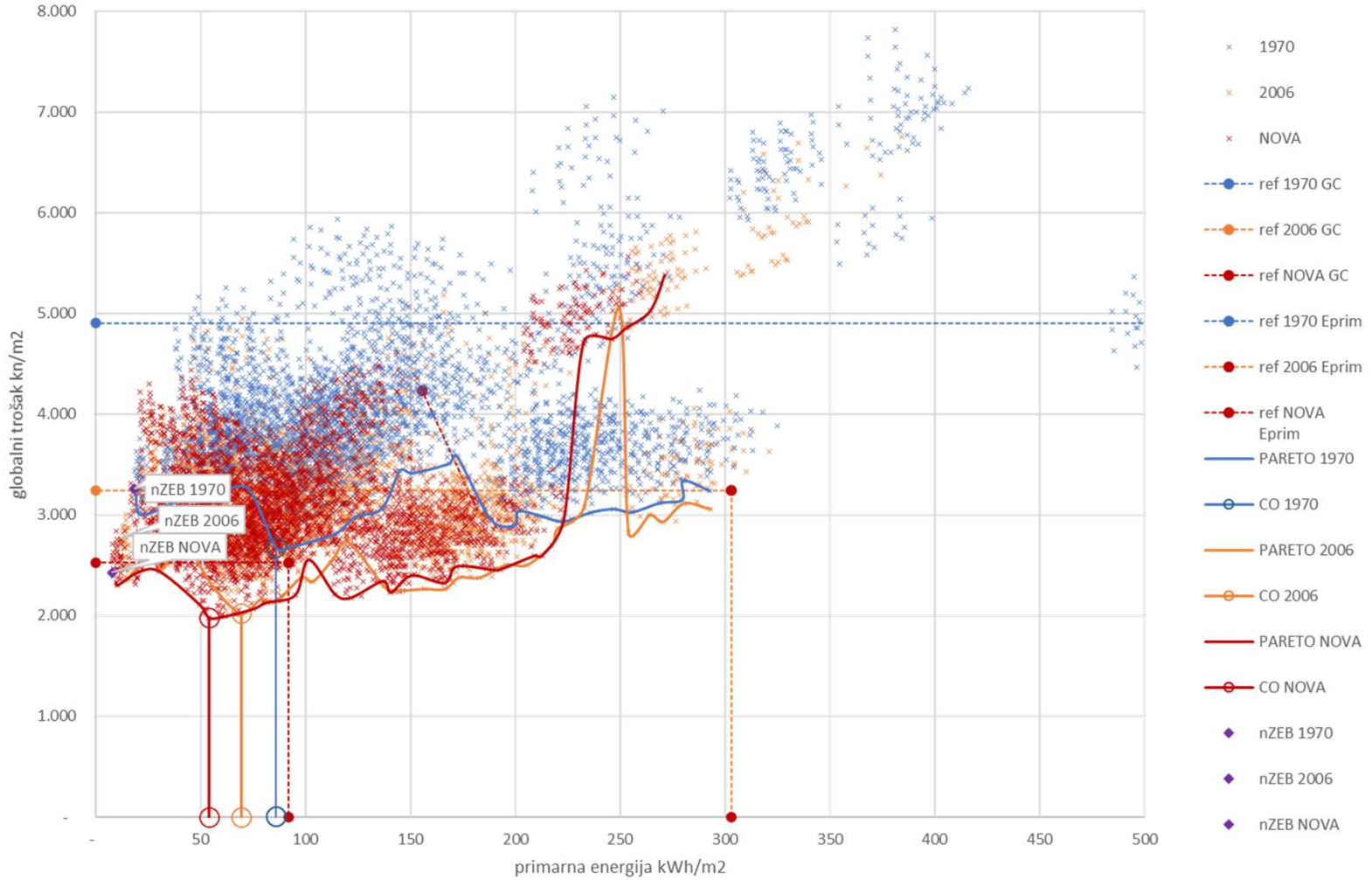
Growth index of the floor area of residential buildings by counties

ID		annual residential area increase index per county	2012/2011	2013/2012	2014/2013	2015/2014	2016/2015	2017/2016
16	K	**Vukovarsko-srijemska**	1,008	1,003	1,002	0,999	1,000	1,002
6	K	**Koprivničko-križevačka**	1,004	1,002	1,002	1,002	1,002	1,003
2	K	**Krapinsko-zagorska**	1,004	1,004	1,002	1,002	1,002	1,002
14	K	**Osječko-baranjska**	1,004	1,005	1,002	1,002	1,001	1,002
3	K	**Sisačko-moslavačka**	1,004	1,003	1,005	1,001	1,001	1,001
7	K	**Bjelovarsko-bilogorska**	1,005	1,003	1,003	1,002	1,002	1,002
4	K	**Karlovačka**	1,003	1,003	1,004	1,003	1,002	1,002
10	K	**Virovitičko-podravska**	1,007	1,003	1,002	1,002	1,002	1,002
11	K	**Požeško-slavonska**	1,006	1,003	1,003	1,003	1,003	1,002
5	K	**Varaždinska**	1,007	1,003	1,003	1,004	1,004	1,004
12	K	**Brodsko-posavska**	1,007	1,005	1,003	1,004	1,003	1,004
1	K	**Zagrebačka**	1,008	1,005	1,003	1,003	1,003	1,003
21	K	**Grad Zagreb**	1,008	1,005	1,004	1,004	1,003	1,007
17	J	**Splitsko-dalmatinska**	1,008	1,005	1,006	1,006	1,005	1,006
20	K	**Međimurska**	1,007	1,005	1,006	1,005	1,006	1,008
15	J	**Šibensko-kninska**	1,008	1,007	1,006	1,005	1,005	1,007
9	J	**Ličko-senjska**	1,008	1,007	1,006	1,010	1,008	1,007
8	J	**Primorsko-goranska**	1,012	1,009	1,007	1,006	1,007	1,007
19	J	**Dubrovačko-neretvanska**	1,011	1,011	1,008	1,006	1,008	1,008
18	J	**Istarska**	1,014	1,010	1,009	1,007	1,007	1,010
13	J	**Zadarska**	1,013	1,010	1,008	1,009	1,008	1,012

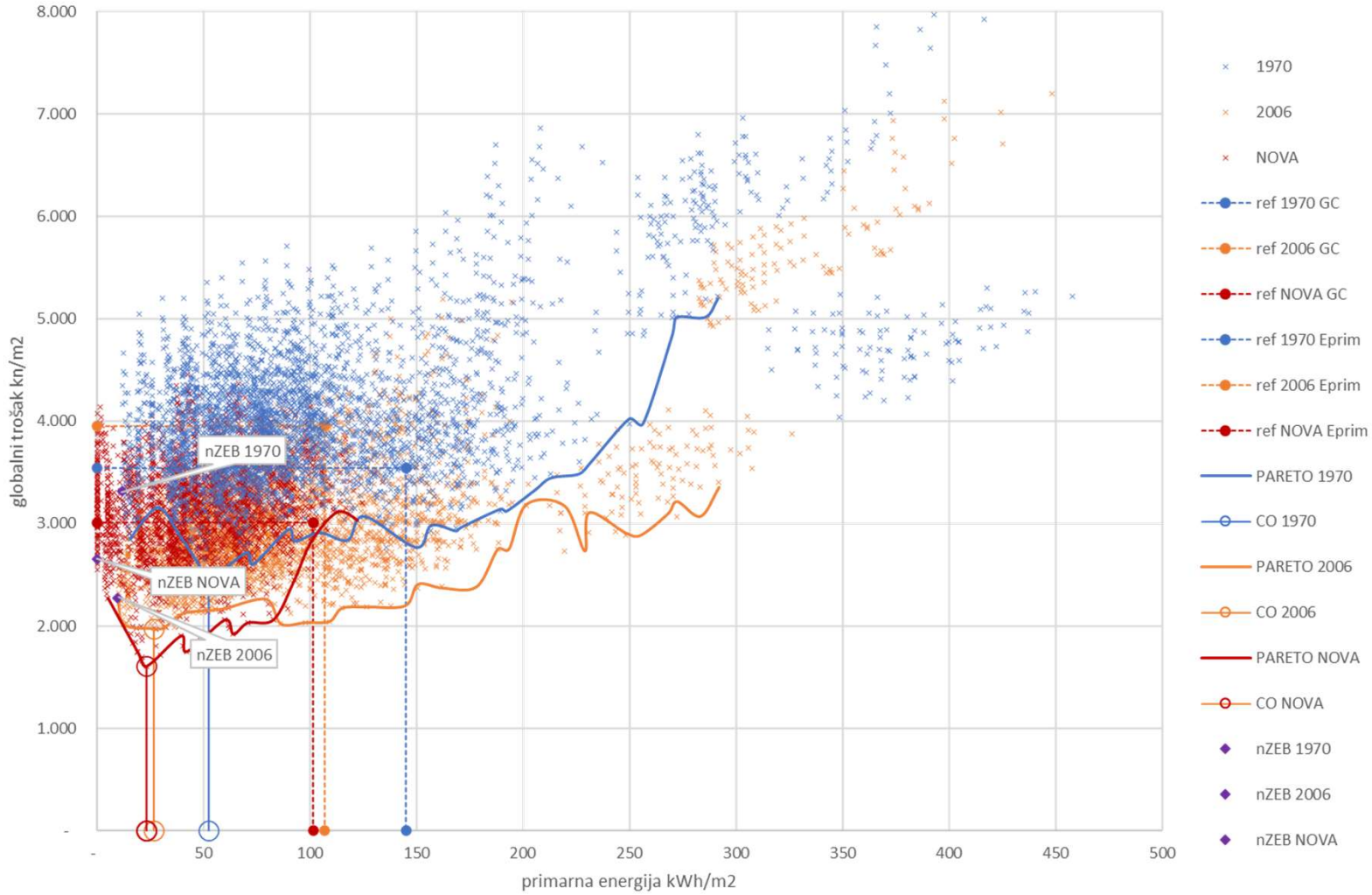
nZEB requirements comparison



Multiapartment building – continental Croatia



Multiapartment building – coastal Croatia

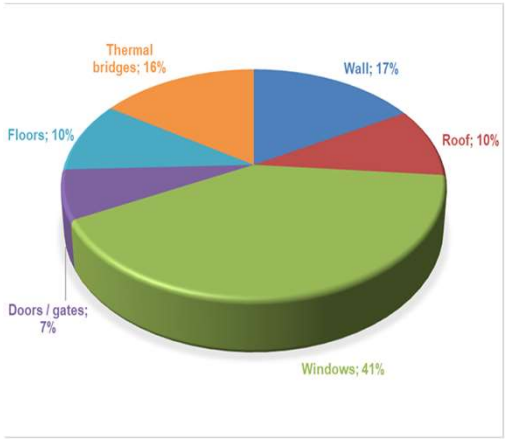


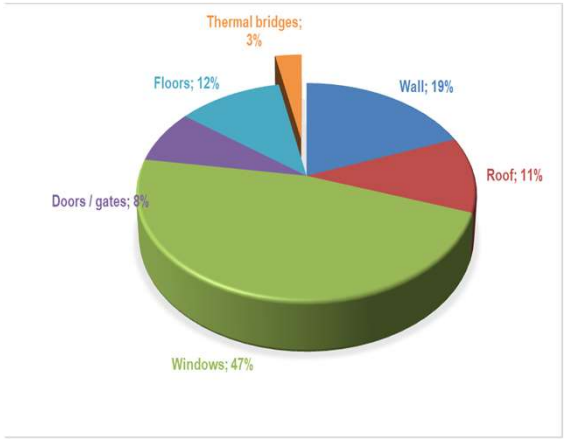
Building envelope

Građevni dio	Prosječni U faktor W/m^2K	Najniži U faktor W/m^2K	Najviši U faktor W/m^2K
Zid	0.29	0.065	1.97
Prozor	1.16	0.70	4.5
Krov	0.14	0.06	0.55
Pod na tlu	0.29	0.07	1.97
Vrata	0.98	0.68	2.19

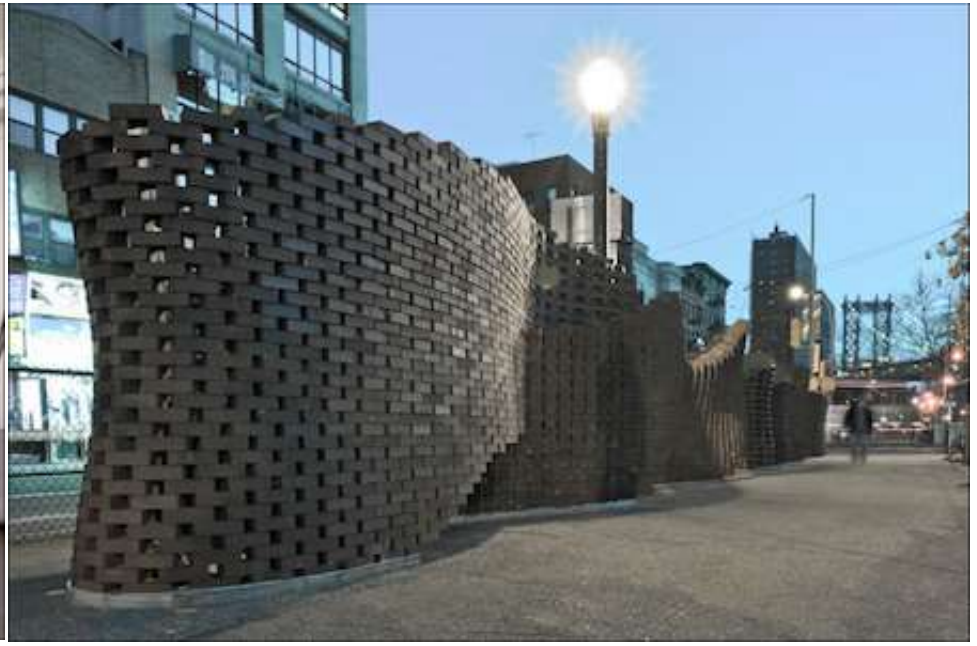
Izvor: Selected examples of nZEB - Detailed Report – Heike Erhorn Kluttig, Hans Erhorn

Preporuke:
- detaljni proračun toplinskih mostova
- smanjenje zrakopropusnosti ovojnice





Building technologies



Gramazio & Kohler

Architektur und Digitale Fabrikation
ETH Zürich - Departement Architektur

http://www.dfab.arch.ethz.ch/

Building technologies

Concrete

- layered concrete with adequate consistency
- technique isn't completely fit for the basic material
- structural errors, cracks, cavities, poor layer adhesion

Loughborough university

Agregate and polimer binder

- similar problems as with concrete – cracks, cavities, layering

D-Shape

Sand

sintering of mineral material at high temperature
- solar radiation focused with Fresnell lenses
- Sandbox

Markus Kayser

Building technologies

D-Shape

http://www.d-shape.com

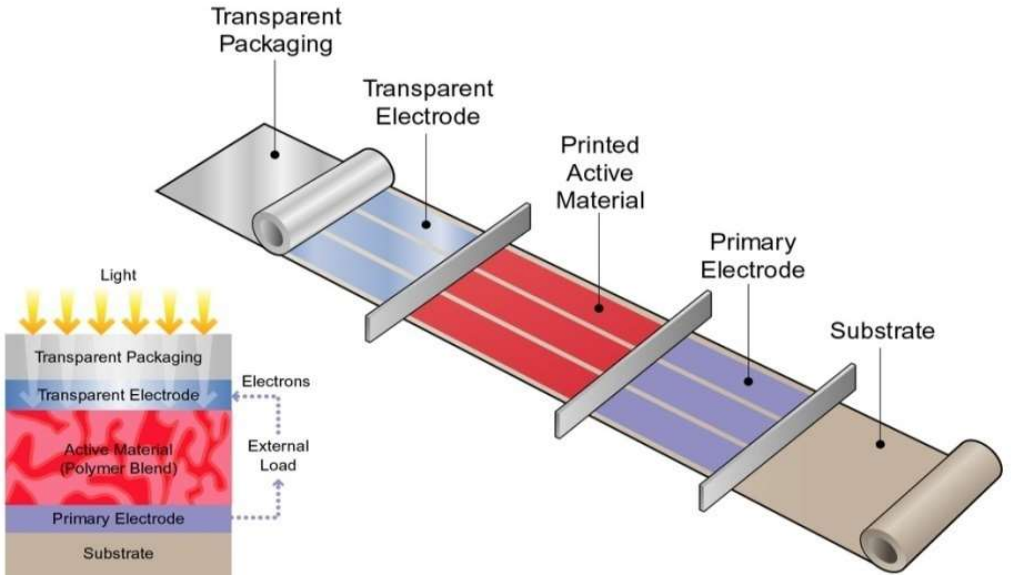
Building technologies

Sungwoo Lim*, Richard Buswell, Thanh Le, Rene Wackrow, Simon Austin, Alistair Gibb, and Tony Thorpe

Department of Civil & Building Engineering, Loughborough University, UK

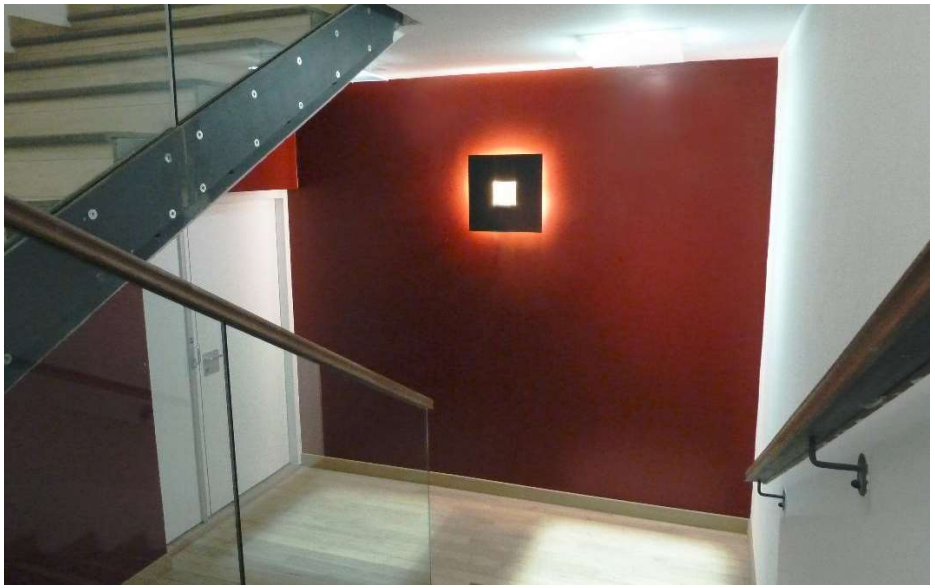
http://www.lboro.ac.uk/

Renewable energy sources

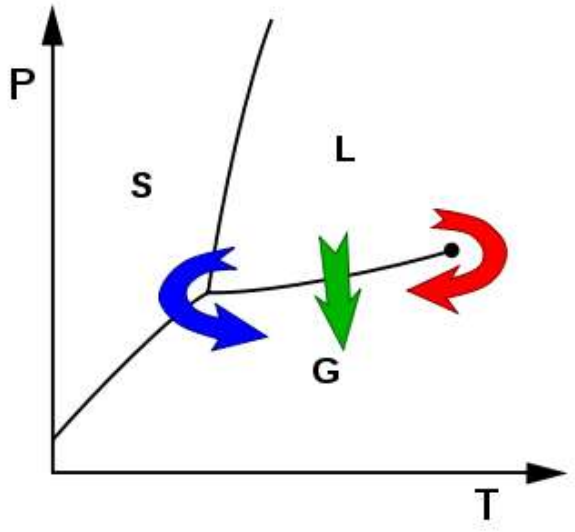


Konarka Technologies Inc.

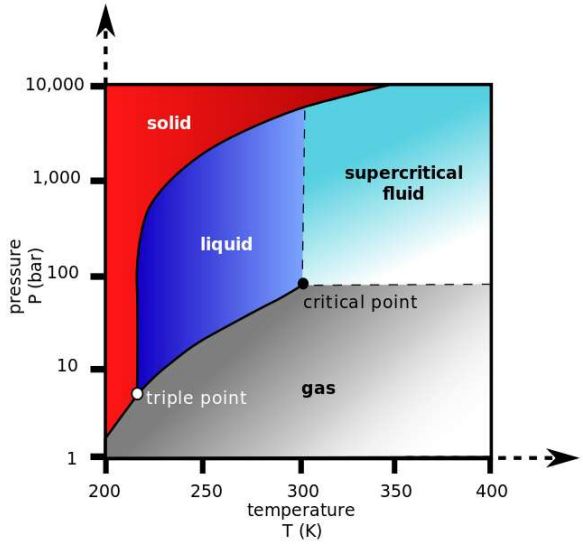
Renewable energy sources



Materials



http://www.airloy.com



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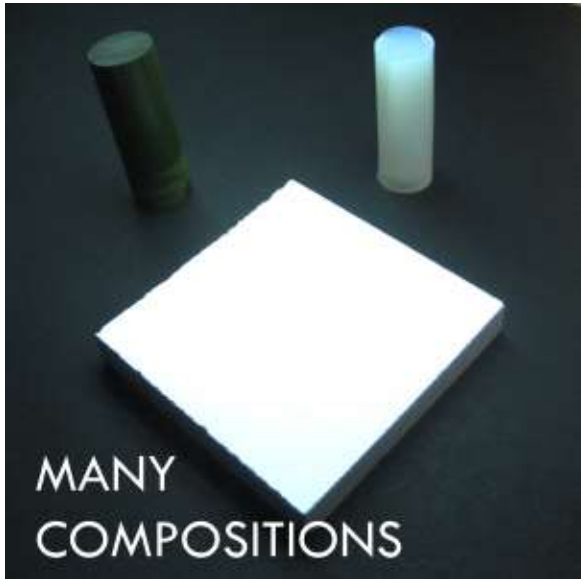

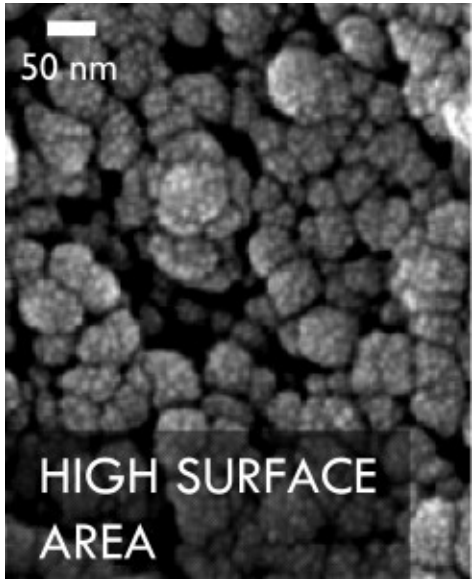

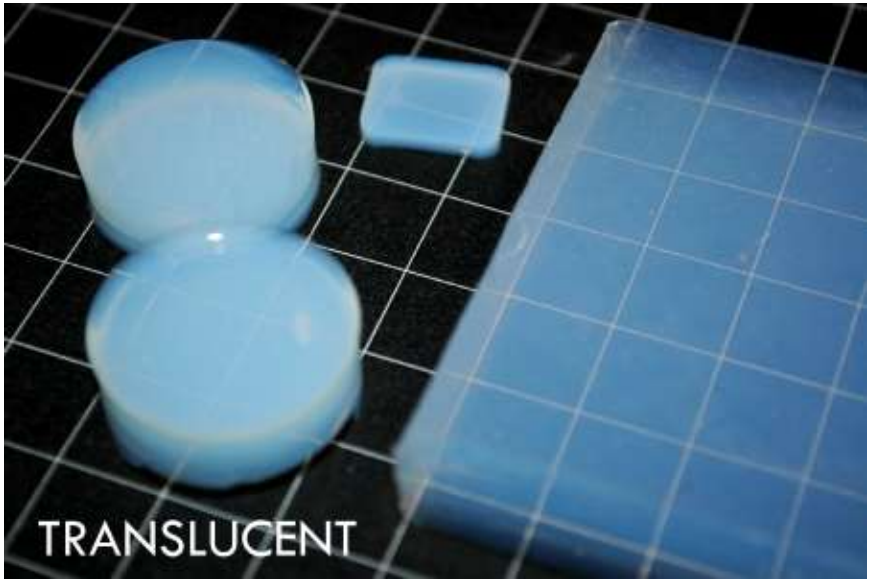

http://www.airloy.com

Business complex
Technological Park Varaždin

architect:
Zdenka Šarolić, dipl. ing. arh.,
Studio Nexar d.o.o.
energy concept:
Željka Hrs Borković, d.i.a. and associates

Eprim = 17 kWh/m²
RES = 72%

Boutique hotel 4* Novi Vinodolski

architect:
MARIN RAČIĆ, dipl.ing.arh.
MR 2 arhitektonski studio d.o.o.
energy concept:
SAEPTUM d.o.o/Željka Hrs Borković, d.i.a. & associates

Eprim = 35 kWh/m^2
RES = 70%

Residential terraces De Duurzame Wijk, Waregem

architecture:
Wielfaert Architecten
energy concept:
3E

building part	U value
wall	0,13
window	0,78
roof	0,13
floor	0,10

technical systems	
1	common biomass boiler for 7 units
2	nearby renewable energy sources
3	gas boiler with PV system – due to the investor preferences

Eprim = -6 kWh/m²
RES = 112%

What has been done so far?

Program	Period	Renovated area m^2
ESCO for public buildings	2014-2015	250.000
ESI funds grants for public buildings	2016-2019	1.350.000
National funds grants for multiapartment buildings	2014-2016	700.000
ESI funds grants for multiapartment buildings	2016-2019	900.000
National funds – grants for single family buildings	2014-2016	2.500.000
TOTAL – renovated area		**5.700.000**

What has to be done?

Period	2021. – 2030.	2031. – 2040.	2041. – 2050.
renovation volume - residential (million m^2)	**17,77**	**24,57**	**18,58**
renovation volume – non-residential (million m^2)	**10,67**	**14,10**	**10,98**
renovation cost – residential and non-residential (billion kn)	**71,24**	**97,26**	**74,73**
total investment cost for renovation (billion kn)		**243,23**	
replacement of demolished - residential (million m^2)	**2,40**	**2,16**	**2,54**
new construction - residential (million m^2)	**9,60**	**9,60**	**10,16**
new construction – non-residential (million m^2)	**3,27**	**2,49**	**1,69**
investment cost for replacement of demolished and new construction (billion kn)	**118,39**	**108,76**	**107,63**
total investment cost for replacement of demolished and new construction (billion kn)		**334,77**	

Thank you!

Toni Borković

Energetski institut Hrvoje Požar