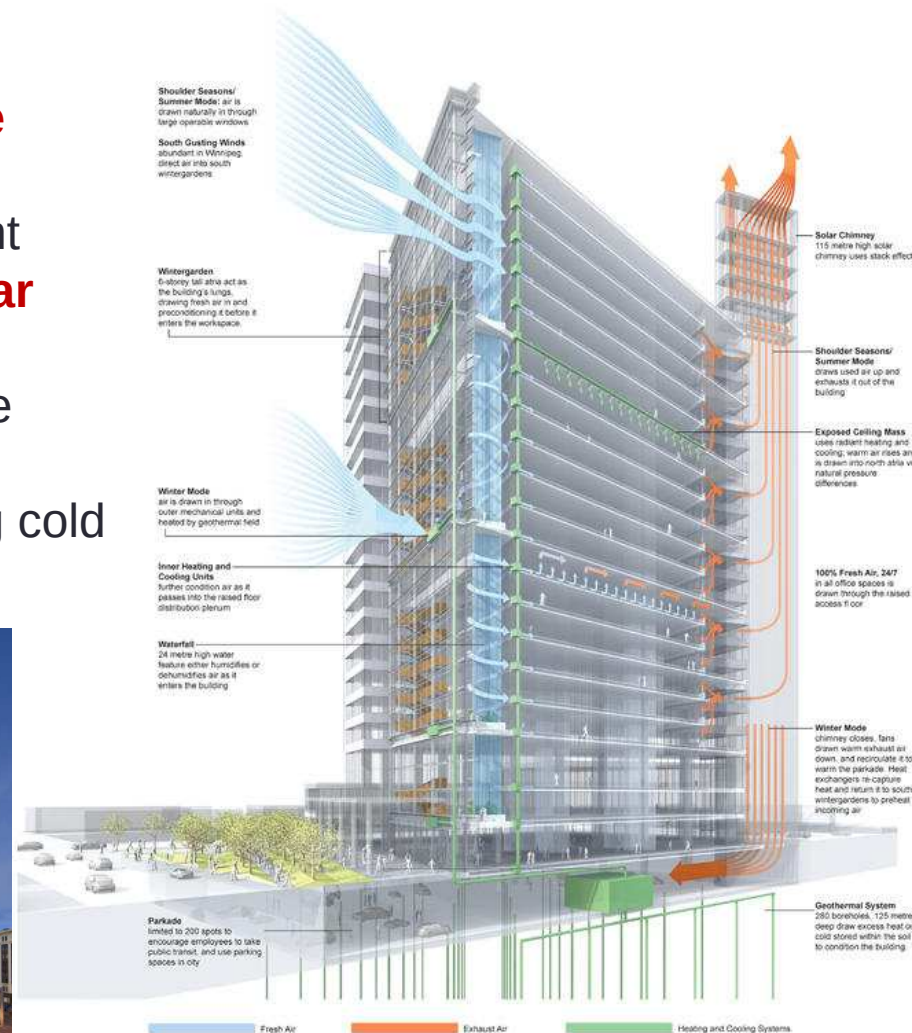


Manitoba Hydro Place

- The design uses the building's **concrete thermal mass** to mitigate extreme temperature swings and integrate radiant heating and cooling systems, with a **solar chimney to provide 100% fresh air by moving exhaust air** to the bottom of the chimney to combine with the atria's preconditioned air and preheat incoming cold air to within room temperature



PROJEKTNI ZADATAK

Variraj parametre...

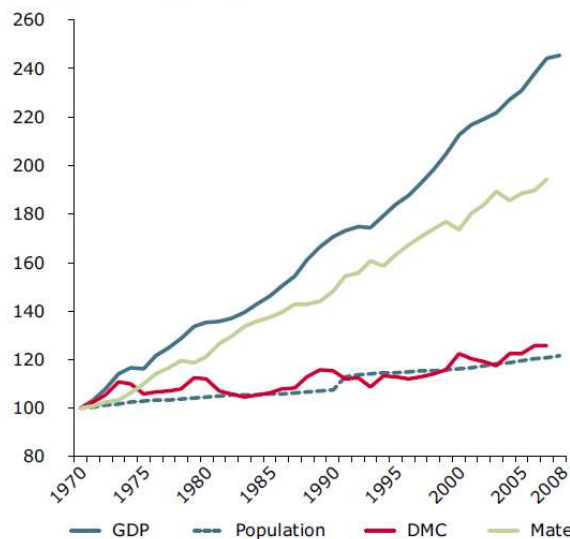
Pronađi optimum!

KOJE MATERIJALE KORISTITI?

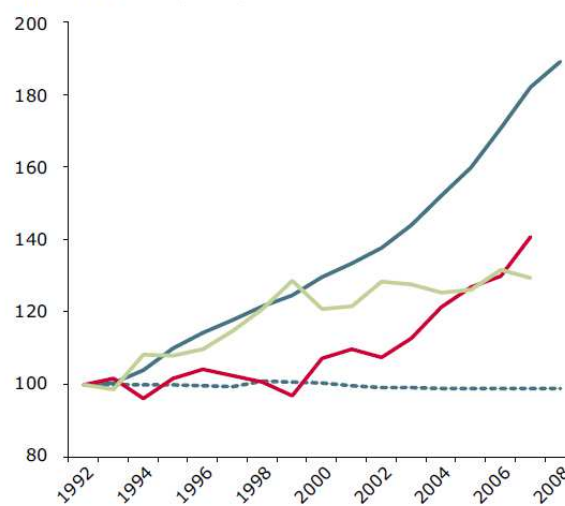
Trendovi

- Globalno korištenje resursa materijala i energije, 1900 do 2005.
- Korištenje materijala i resursa te produktivnost materijala EU-15 i EU-12

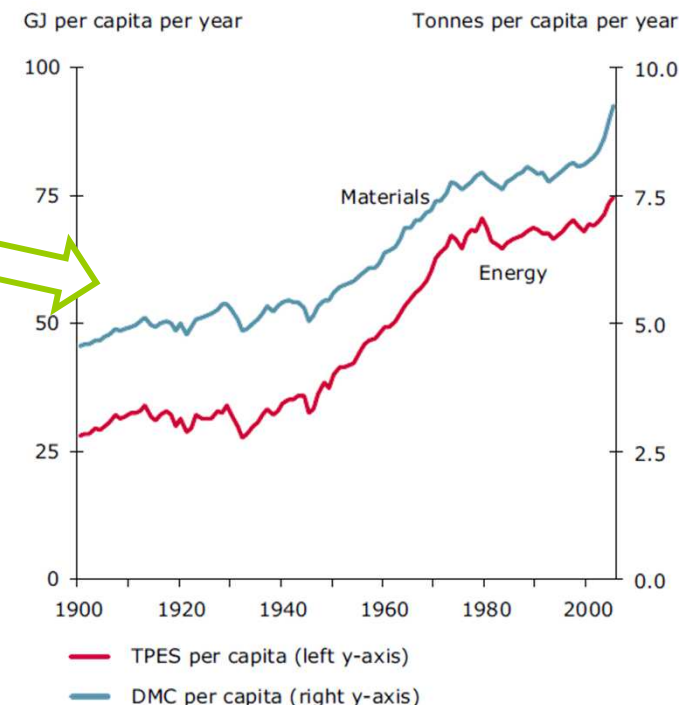
Index 1970 = 100 (EU-15)



Index 1992 = 100 (EU-12)



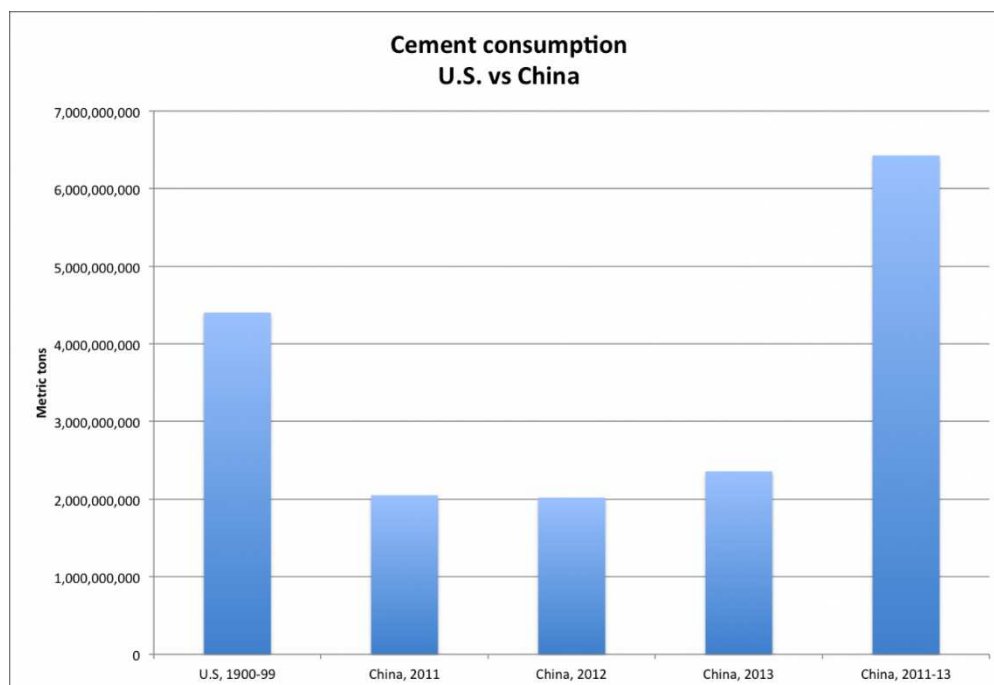
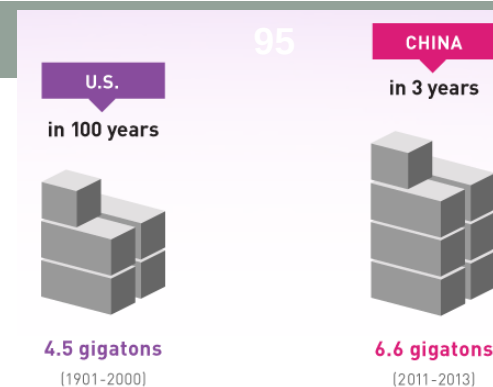
Source: GDP data from The Conference Board — Total Economy Database, September 2010, www.conference-board.org/data/economydatabase/; Population data from Eurostat Database on Population; DMC data for 1970-1999 (EU-15): IFF database; DMC data for 1992-1999 (EU-12): WI database; DMC data for 2000-2007: Eurostat Database on Material Flow Accounts.



Source: Krausmann et al., 2009.

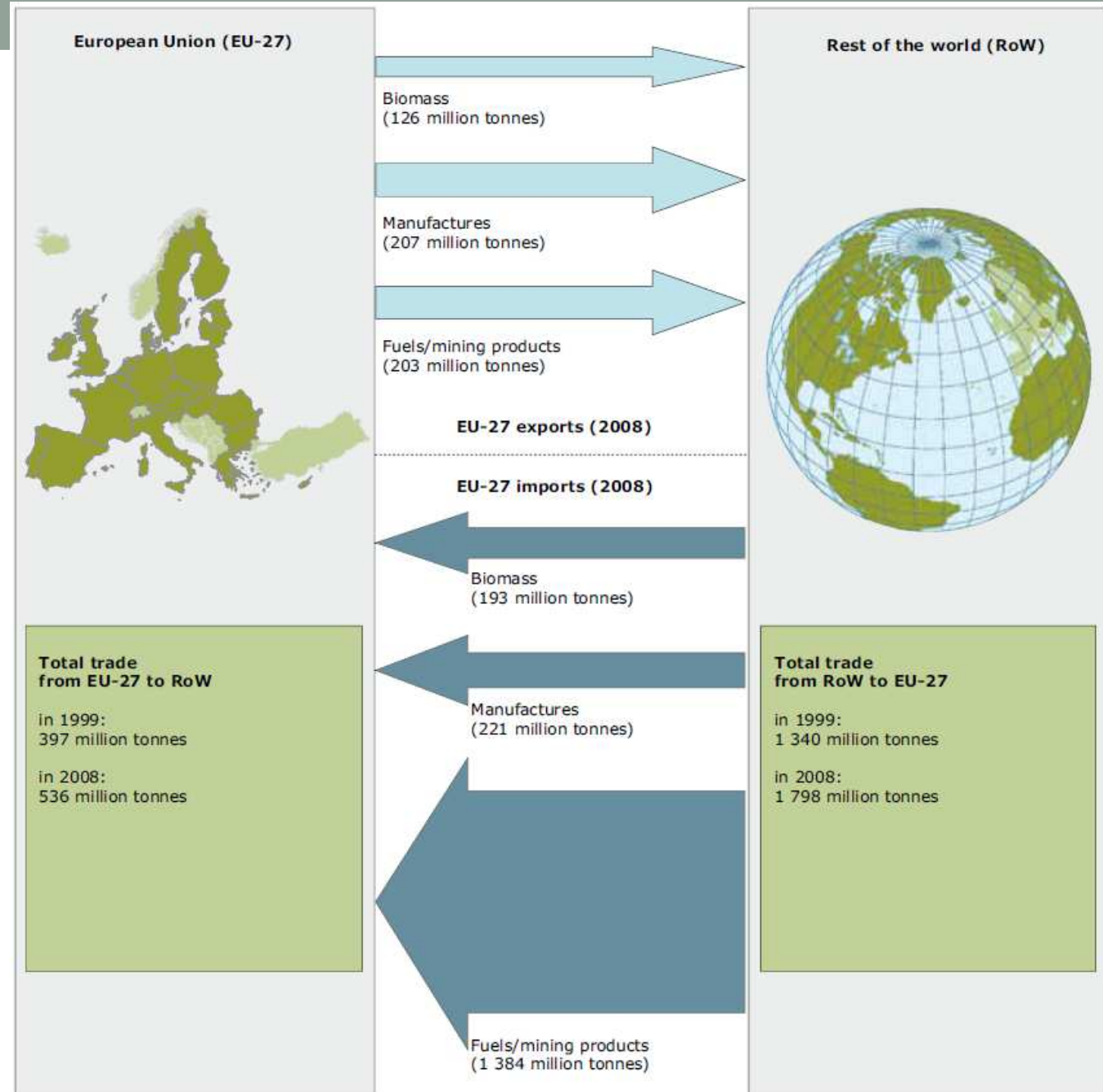
Potrošnja cementa u svijetu...

- How China used more cement in 3 years than the U.S. did in the entire 20th Century
 - Izvor: Ana Swanson; March 24, 2015; The Washington Post



Razlozi:

- zaštita okoliša
- smanjenje ovisnosti o resursima izvan EU



Source: Eurostat Comext statistics.

IZBOR GRAĐEVNOG MATERIJALA

• Kriteriji za ekološku prihvatljivost materijala

- imati najmanji mogući utjecaj na okoliš
- trošiti malo energije
- biti moguće reciklirati
- biti proizveden u blizini
- biti energetske učinkovit
- biti dugotrajan
- proizvoditi minimalne količine otpada
- imati dobar društveni utjecaj
- biti jeftin



Materijali

Prirodni vs Sintetički

Primjer



- Ecosse® mineralna vuna proizvodi se
 - korištenjem **recikliranih staklenih boca, otpadnog stakla, otpada nastalog u samoj proizvodnji mineralne vune**, (85 % sirovina koje se koriste) te silicijskog pijeska.
- BRE Green Guide (BREEAM sustav)
 - materijal **ne sadrži štetne tvari poput formaldehida, fenola, pentana, butana i akrila**
 - za proizvodnju potrebno **do 70 % manje energije** nego u slučaju tradicionalne mineralne vune

breeam

Ocjena Ecosse® mineralne vune



Utjecaj na okoliš	Izolacijski materijal od staklene vune – gustoća 32 kg/m³	Ovčja vuna gustoće 25 kg/m³	Slama kao TI
	Ocjena	Ocjena	Ocjena
Emisija CO _{2eq}	B	B	A+
Korištenje vode	A+	A+	A+
Korištenje prirodnih resursa	A+	A+	A+
Degradacija ozonskog sloja	A+	A+	A
Toksičnost za čovjeka	A+	A+	C
Toksičnost za pitku vodu	A+	B	E
Nuklearni otpad	A+	A+	A+
Toksičnost za tlo	E	E	A
Odlaganje otpada	A+	A+	C
Korištenje fosilnih goriva	A+	A+	A+
Eutrofikacija	A+	B	C
Potencijal fotokemijskog stvaranja ozona	A+	A+	B
Potencijal stvaranja kiselih kiša	A+	A+	B
Ukupna ocjena	A+	A+	A

- Prirodni
 - minimalno prerađeni u industriji (drvo, slama, kamen, ...)
- Sintetički
 - Industrijski proizvedeni, prošli kroz značajne obrade i manipulaciju (polimeri, ...)

Obje vrste imaju prednosti i nedostatke

- dokazano da se često prirodni materijali ne mogu nositi sa sintetičkima
- **Potrebno vrednovanje ovisno o postavljenim kriterijima**

Koliko je materijal zelen?

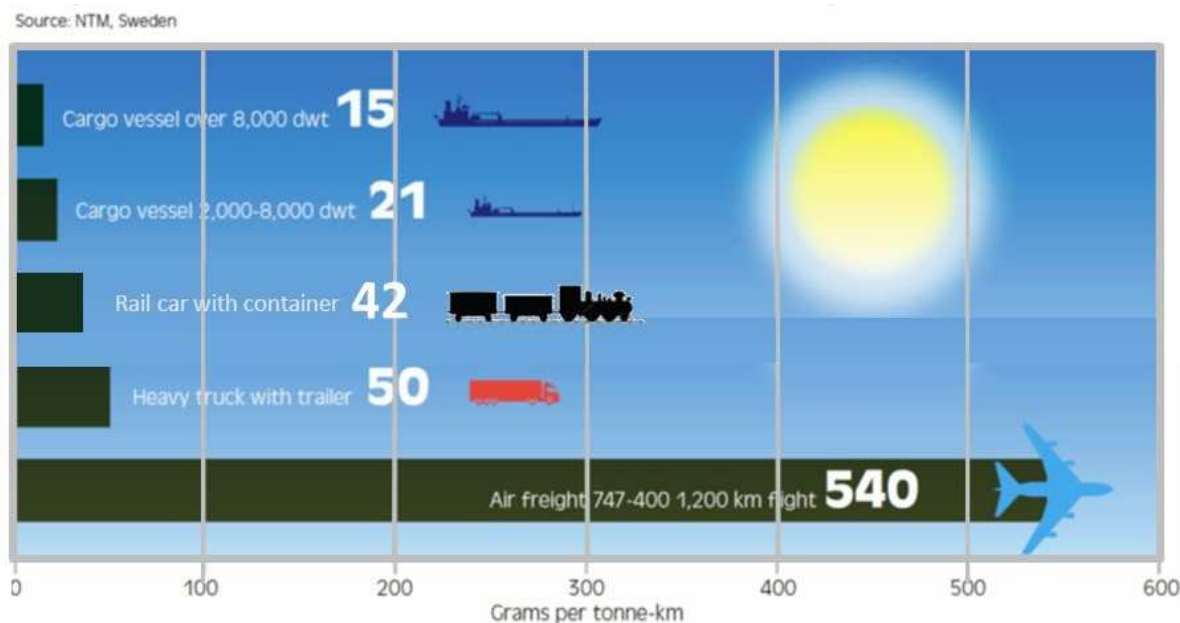
- Protupitanje...
 - Koji je kriterij?
- Je li kriterij...
 - Trajnost materijala
 - Obnovljivost materijala
 - Mala utrošena energija...
 - u proizvodnji
 - kod prijevoza i ugradnje
 - tijekom korištenja
 - tijekom razgradnje
 - Bez štetnih sastojaka i emisija za korisnike, radnike i okoliš
 - Cijena
 - ...



Transport materijala

Utjecaj transporta na okoliš?

- Usporedba emisije CO₂ različitih načina transporta

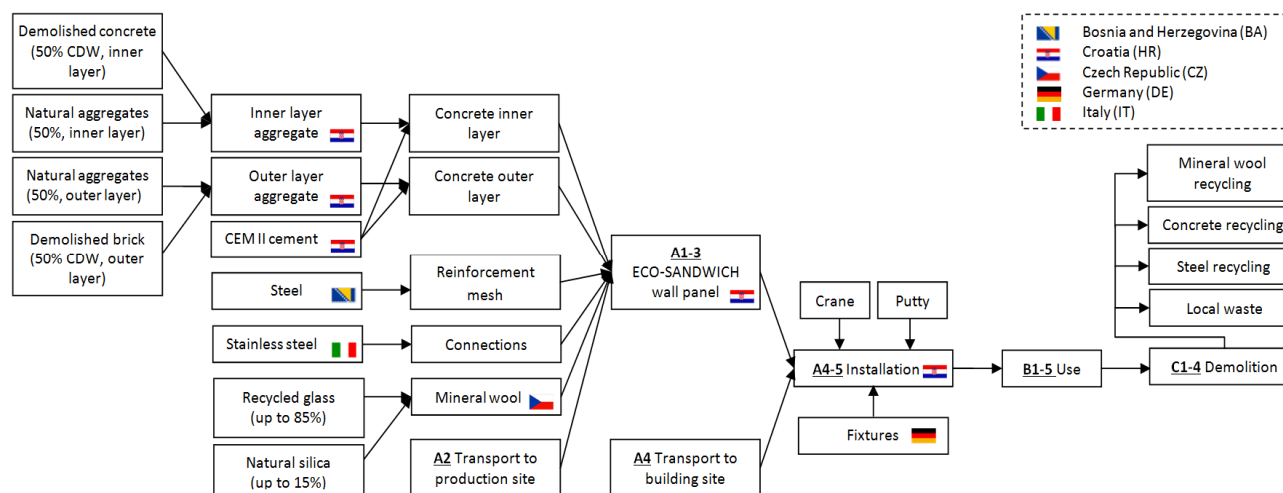


Izvor: 2013 VA Governor's Transportation Conference Ed McCarthy, SVP & COO

<https://slideplayer.com/slide/3224537/>

Primjer – ovčja vuna

- U Hrvatskoj se striženjem dobiva cca 1200 t/god
 - Ne skuplja se i ne obrađuje u značajnim količinama
 - Na tržištu ovčja vuna iz drugih zemalja EU i BiH
- **Utjecaj transporta** na ekološki otisak proizvoda?
- Nije odgovarajuća za sve primjene!



ŽIVOTNI CIKLUS GRAĐEVNOG PROIZVODA



Higrotermalna svojstva materijala

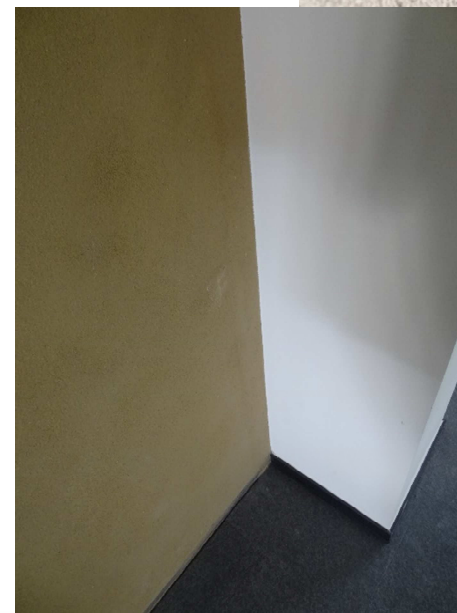
- Difuzija vodene pare
- Apsorpcija i desorpcija vlage - Reguliranje RH prostora



ili



=



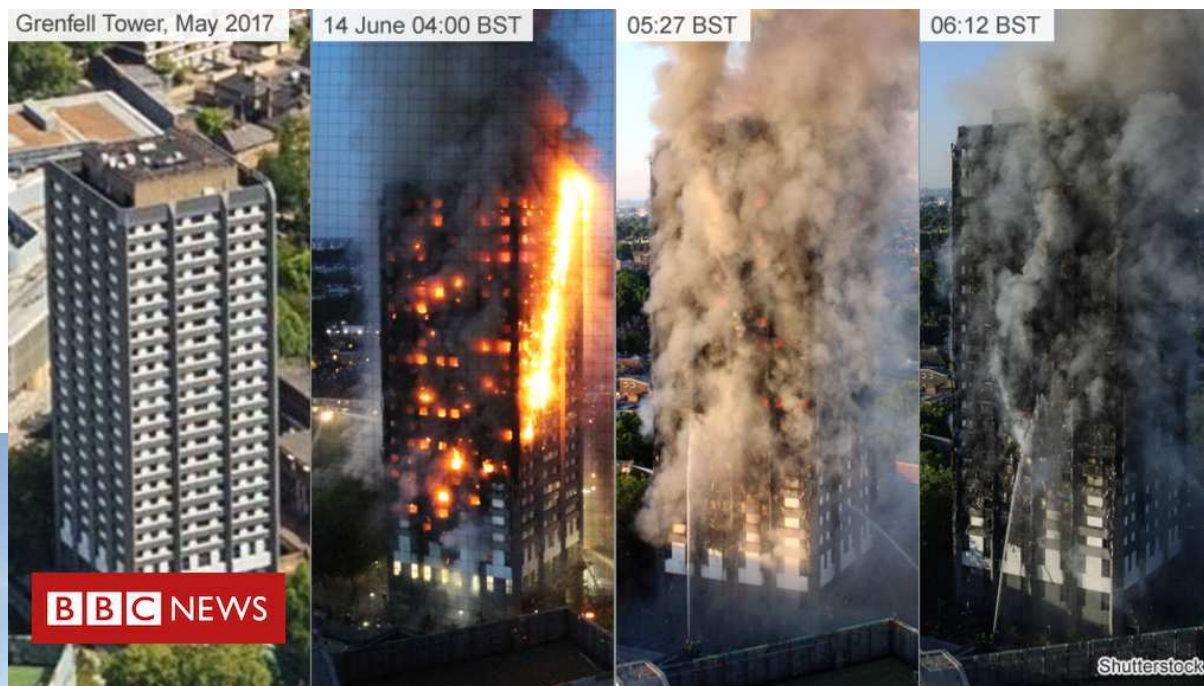
Primjer glinene žbuke

Sigurnost



Požar – studentski dom Cvjetno naselje, Zagreb

Izvor: www.Srednja.hr



Požar – Grenfell Tower London

Izvor: www.BBC.com

PROJEKTNI ZADATAK

Variraj materijale...

Pronađi optimum!

OTPAD... ILI RESURS?



Očuvanje prirode ili iskorištavanje resursa?

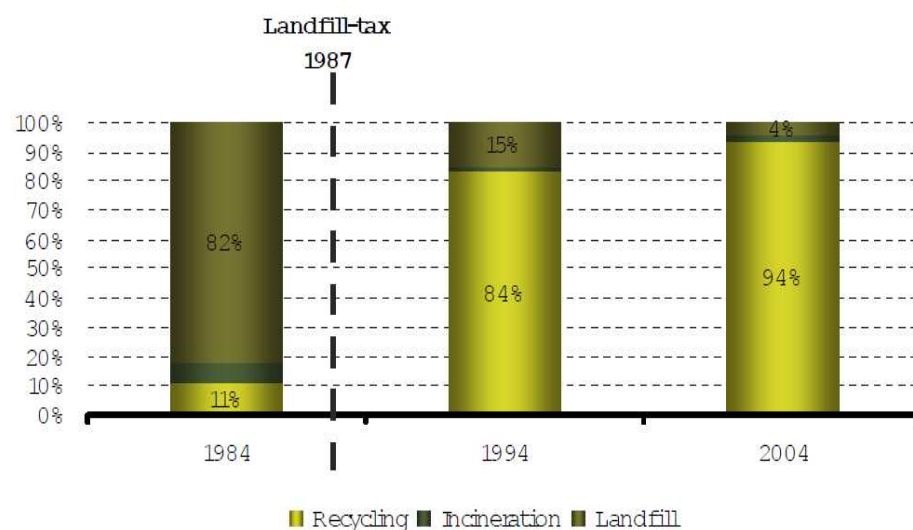


OTPAD: Problem ili Novi Resurs?



Dansko iskustvo

- Danska je 2004. g reciklirala **94% CDW-a!!!**



Source: Eionet (2006a), Country fact sheet Denmark



The waste hierarchy, as defined by the Waste Framework Directive (2008/98/EC)

Temeljni zahtjevi za građevinu

- 7. Održiva upotreba prirodnih izvora
 - Građevina mora biti **projektirana, izgrađena i srušena tako da je upotreba prirodnih izvora održiva** i da je posebno zajamčena:
 - **ponovna upotreba ili recikliranje građevine, njezinih materijala i dijelova nakon rušenja**
 - **trajnost građevine**
 - **upotreba sirovina i sekundarnih materijala u građevini u skladu s okolišem**
- o **Uredba 305/2011** Europskog parlamenta i Vijeća od 09.03.2011. koja propisuje usklađene uvjete trgovanja građevnim proizvodima i ukida
- o **Zakon o gradnji** - u izradi



Od otpada do proizvoda

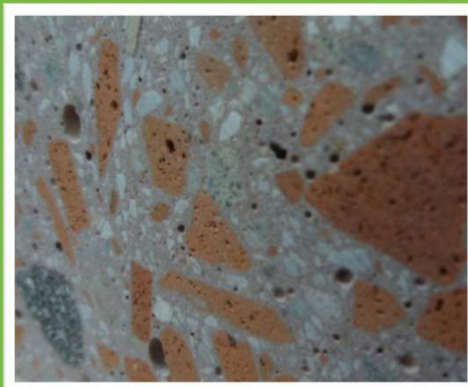
WASTE



RESOURCE



MATERIAL



PRODUCT



Primjer - Waldspirale

- Stambeni kompleks u Darmstadtu izgrađen tijekom 1990-tih
 - Arhitekt: Friedensreich Hundertwasser
- Izgrađena korištenjem 12.000 m³ recikliranog betona
 - Smanjenje korištenja prirodnih resursa – pijeska i šljunka
 - Smanjenje količine otpada nastalog rušenjem.



Slama... Otpad ili resurs?



Gradnja slamom

- gradnja slamom je izuzetno jeftina (15× u odnosu na opeku ili beton)
- trend u svijetu-VB-nekoliko tisuća objekata godišnje



Primjeri...



Dekonstrukcija postojećih zgrada i gradnja nove

kuća ČV1 - Kupinečki Kraljevec, 2008

Arhitekt: Ljubomir Miščević

- Otpadna opeka – obloga ovojnice prizemlja
- Dekonstrukcija stogodišnjeg štaglja – obloga ovojnice 1. kata



Dekonstrukcija postojeće zgrade i gradnja nove

- Osnovna škola Brezovica pri Ljubljani
- Arhitekt: Slavko Gabrovšek



- rušenje stare zgrade
- razdvajanje građevinskih materijala
 - pažljivo uklanjanje,
 - razdvajanje
 - zaštita
 - priprema za ponovnu ugradnju

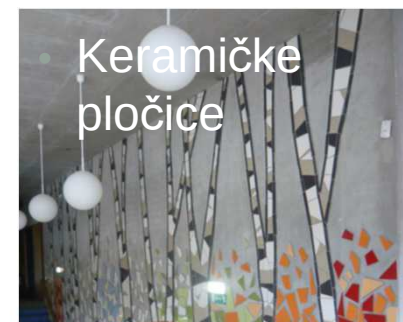
Dekonstrukcija postojeće zgrade i gradnja nove

Izvor: Slavko Gabrovšek, arhitekt

• Opeka



• Krovne ploče



Keramičke pločice



Fasadne ploče

HRVATSKI INŽENJERSKI SAVEZ
CROATIAN ENGINEERING ASSOCIATION



Projekt je sufinancirala Europska unija iz Europskog socijalnog fonda.



CPD4GB

PROFESIONALNIH KOMPETENCIJA
ZA ZELENU GRADNJU
CONTINUOUS PROFESSIONAL DEVELOPMENT
FOR GREEN BUILDING

PREDGOTOVLJENA GRADNJA?

Održivost predgotovljene gradnje?

- **McGraw-Hill Construction**

- ...This reemergence of prefab and modular **as a “new” trend is tied to the rise of BIM and green building, critical new trends** identified by McGraw-Hill Construction and other industry leaders....



McGraw Hill Construction provides essential data, news, insights, and intelligence to better inform construction professionals' decisions and strengthen their market position.



PREDNOSTI PREDGOTOVLJENE GRADNJE

- Ključne prednosti:
 - **Brzina gradnje (do 70% brža gradnja),**
 - **Ekonomičnost i**
 - **Kvaliteta gradnje**
- This approach can offer **faster, cleaner and safer working conditions on site** and so be of benefit to clients, contractors and others involved in the process.

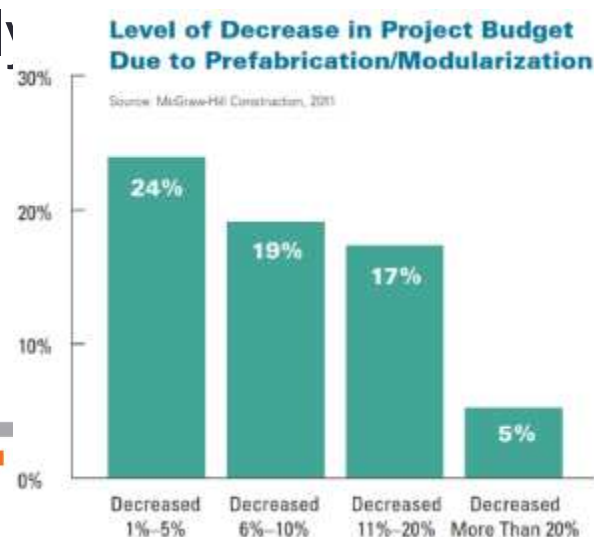
Izvor:



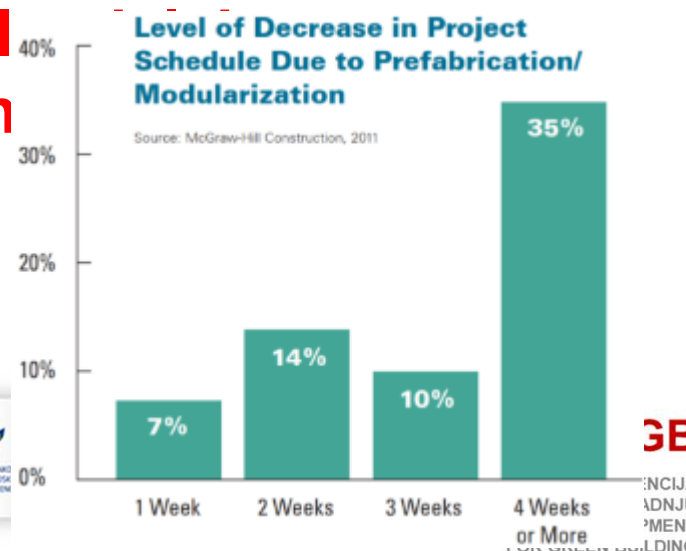
- Consequently

Izvor:

McGraw-Hill Construction
The data are based on a survey of 809 contractors, architects and engineers.



in l
an



PREDNOSTI PREDGOTOVLJENE GRADNJE

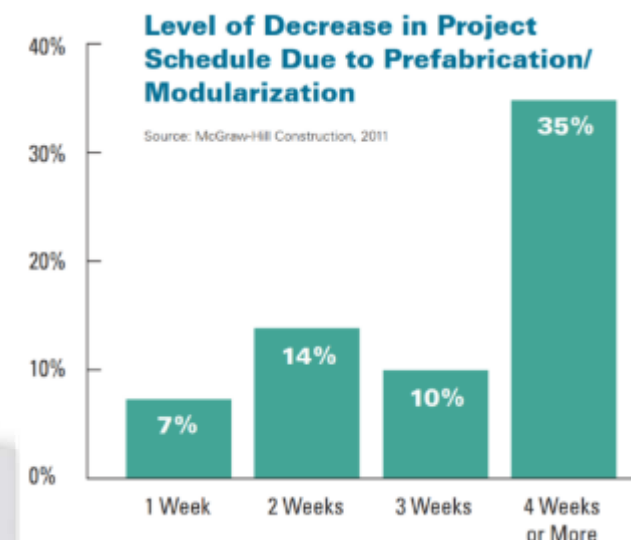
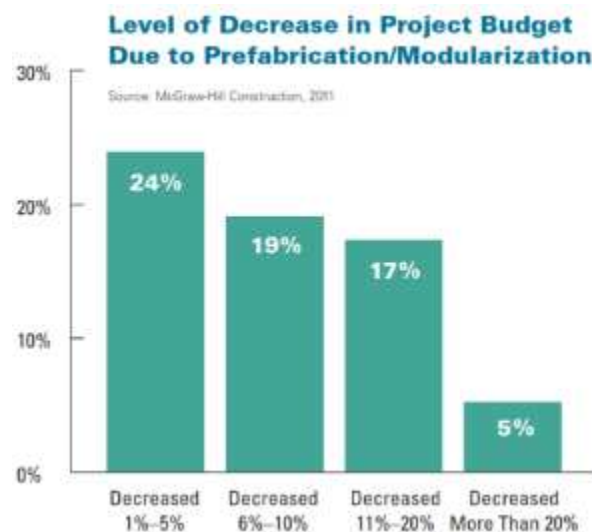
- Ključne prednosti:
 - **Brzina gradnje (do 70% brža gradnja),**
 - **Ekonomičnost i**
 - **Kvaliteta gradnje**
- This approach can offer **faster, cleaner and safer working conditions on site** and so be of benefit to clients, contractors and others involved in the process.
- Consequently, there are **savings in land, labour, rents, overheads and financing costs, and a faster return on investment.**



Izvor:

Izvor:

McGraw-Hill Construction
The data are based on a survey of 809 contractors, architects and engineers.



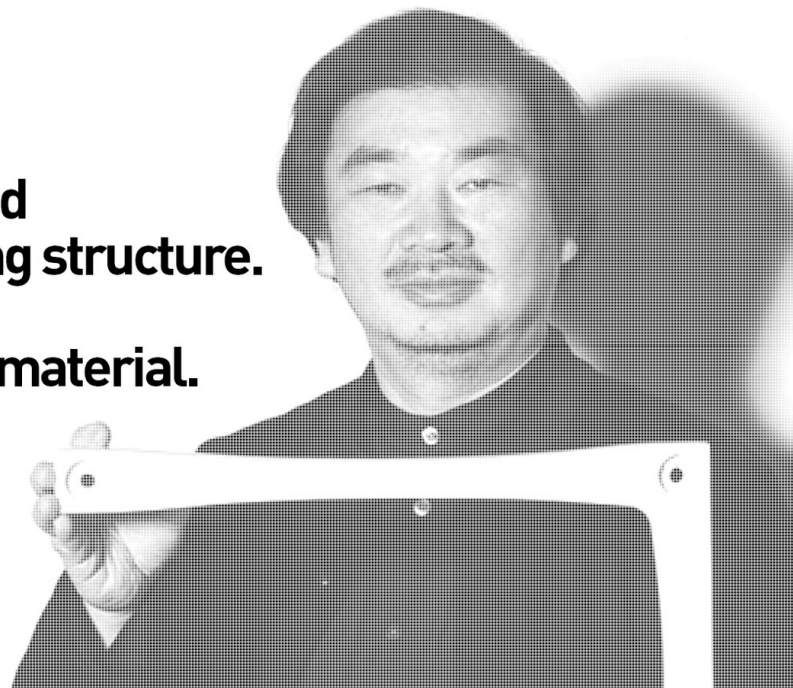
Održivost predgotovljenih sustava

- Report - **Journal of Industrial Ecology** (Quale et al 2012)
- **prefabricated construction has fewer impacts, on average, than on site construction for all environmental impact categories studied.**
 - ...**noise and traffic congestion are also greatly reduced** as a result of decreased on-site construction, along with decreased pollutants...
 - ...the issue of **recycling and waste is potentially more manageable** in modular building...
 - the assembly line techniques associated with off-site factory construction allow predictability and consistency among parts;
 - this **significantly reduces building waste** of modular constructed projects.
 - ...the modularity increases **the ease associated with the disassembling of parts required in order to recycle building materials after the building is no longer used.**

OUT OF THE BOX THINKING

**I believe that the material doesn't need
to be strong to be used to build a strong structure.
The strength of the structure
has nothing to do with strength of the material.**

Shigeru Ban



Primjer promišljanja - Shigeru Ban



Izvor: <https://www.designboom.com/architecture/shigeru-ban-onagawa-temporary-container-housing-community-center/>

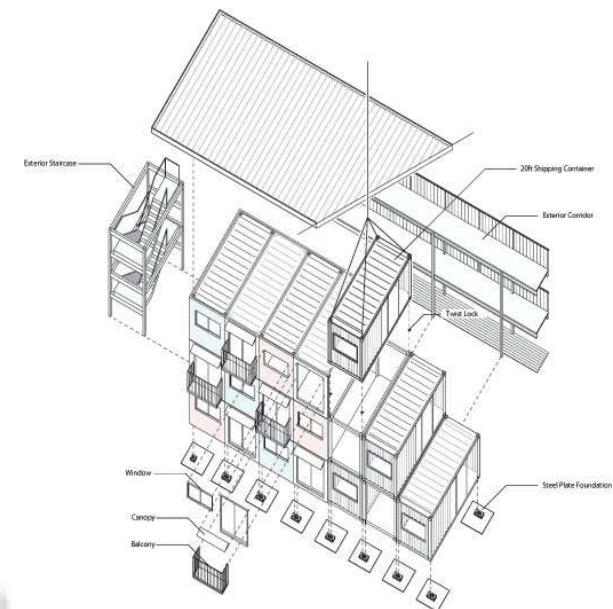
Primjer promišljanja - Shigeru Ban

- used **steel shipping containers** to construct what was planned to be temporary accommodations for **displaced persons after an earthquake in 2011**.
 - The scarcity of flat land led to the development of a 3-storey structural framework to allow stacking the 6m units in checkerboard fashion.
 - Its amenity and excellent seismic performance allowed the building to be used as a permanent solution

Izvor: <https://www.designboom.com/architecture/shigeru-ban-onagawa-temporary-container-housing-community-center/>



Temporary housing , Onagawa, Japan



- Paper Concert Hall - L'Aquila / Italy / 2010

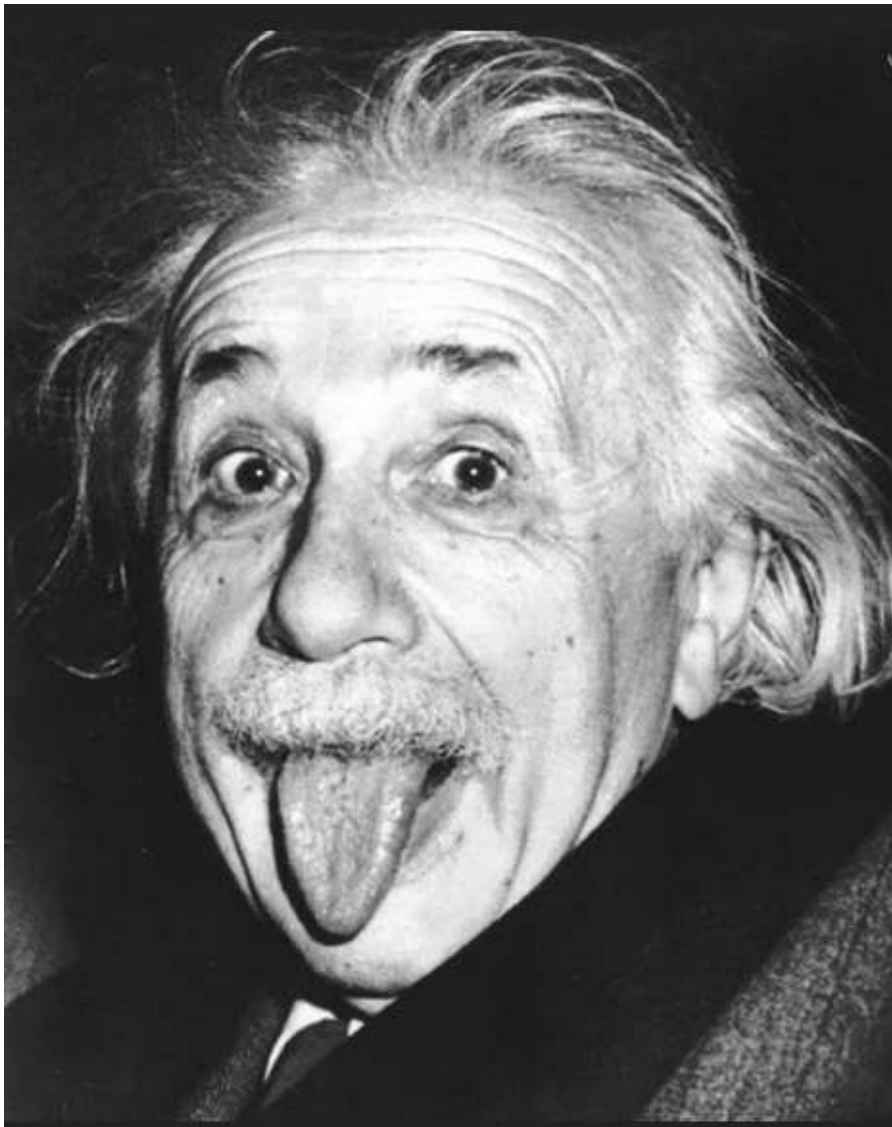


<https://www.designboom.com/architecture/shigeru-ban-paper-concert-hall-in-laquila/>

Primjer promišljanja - Shigeru Ban

- **Temporary substitute** for the Conservatorio Alfredo Casella that was destroyed in the 2009 earthquake.
- The temporary hall built of a number of different materials including **cardboard can be taken apart and re-used** at another location after reconstruction of the permanent hall.
- Students from three different countries helped with the construction.

SIMPLICITY OF THE SOLUTION, --- BORN OUT OF NEED



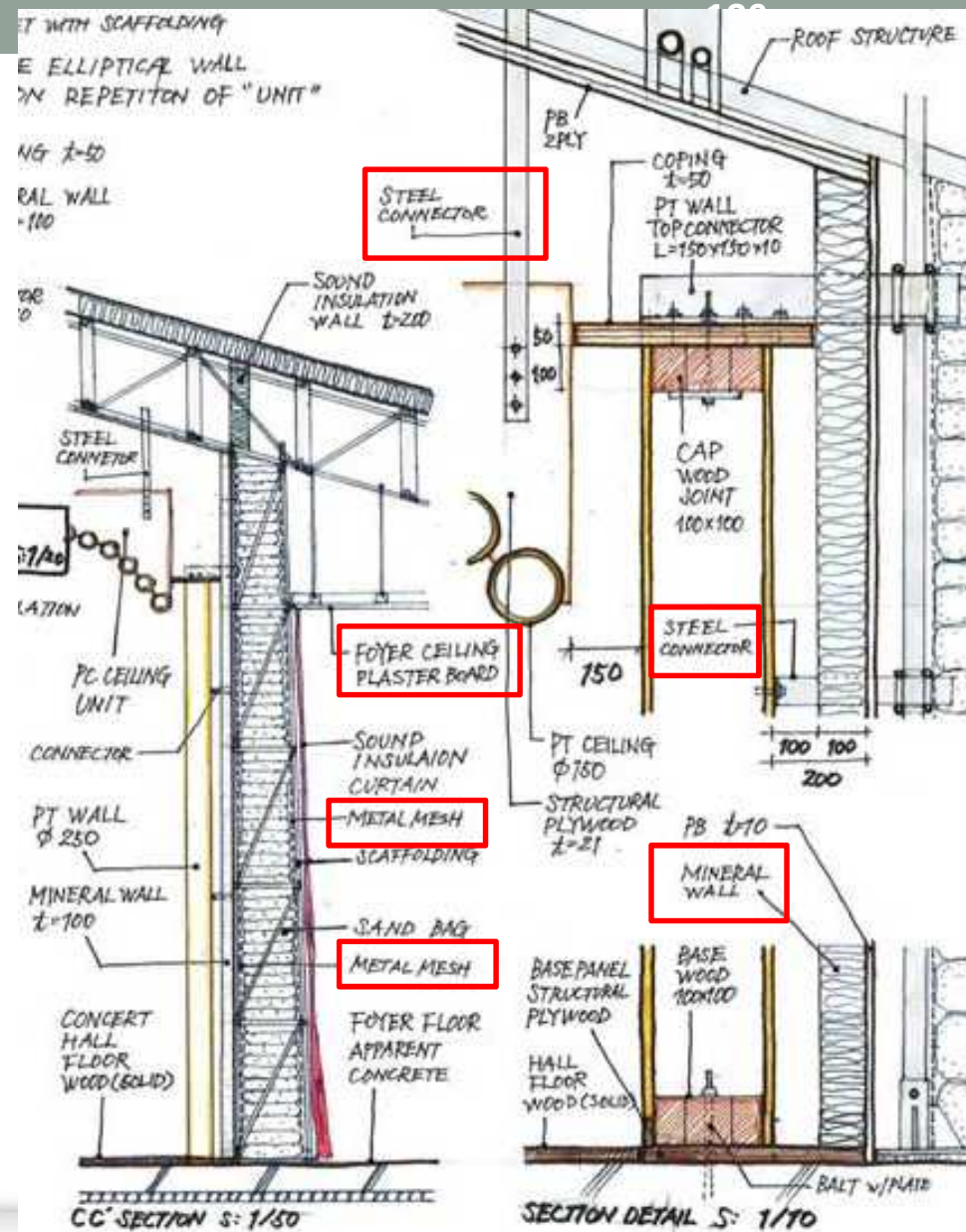
”Make everything
as simple as possible, but
not simpler.”

Granice za održivost?

- Svaki materijal ima svoju namjenu.
- Ponekad su potrebni kompromisi!



Izvor: <https://www.designboom.com/architecture/shigeru-ban-paper-concert-hall-in-laquila/>



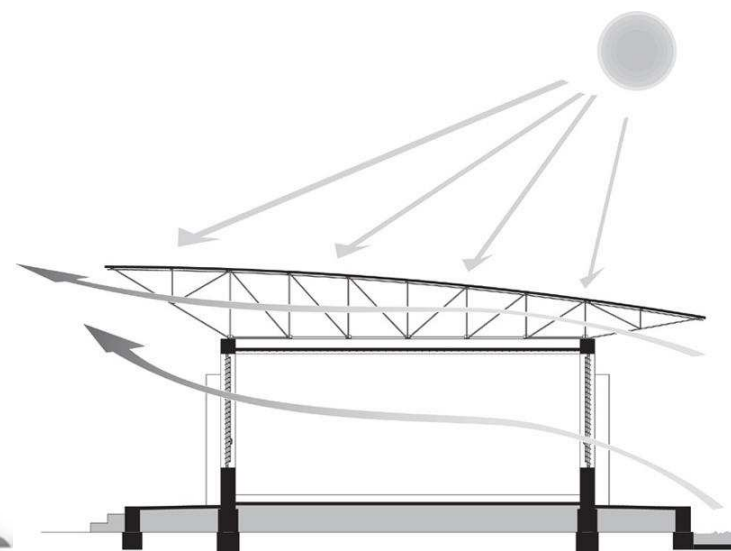
Primjer promišljanja - Diébédó Francis Kéré

- Gando Primary School, Burkina Faso
 - clay bricks (clay+cement+sand) and the corrugated metal roof on lightweight steel trusses keeps the seasonal rains from washing the mud bricks away.
 - entire local population involved in the construction.
 - Large overhangs offer shade, the patios bring relieve from the monotony of the flat savanna
 - Ingenuity, economy and simplicity drove the design.



Primjer promišljanja - Diébédo Francis Kéré

- Born in the village of Gando in Burkina Faso, he was the **village's first child to be sent to school** because his father, the village chief, needed someone who could read and write.
 - Djeca hodaju u školu 20 km/dan
- After his graduation in Berlin he formed an association ("Bausteine für Gando") **with the objective to raise the resources to build the first school in his native village**.
 - **Budžet 30.000 \$**
 - Cilj je bio škola za 120 djece
 - (sada imaju više od 700 djece)
 - najbolja škola u regiji!



ANKETA

Green building survey...



Zelena gradnja?

Da / Ne?

Ugrađena energija (Embodied energy) - info

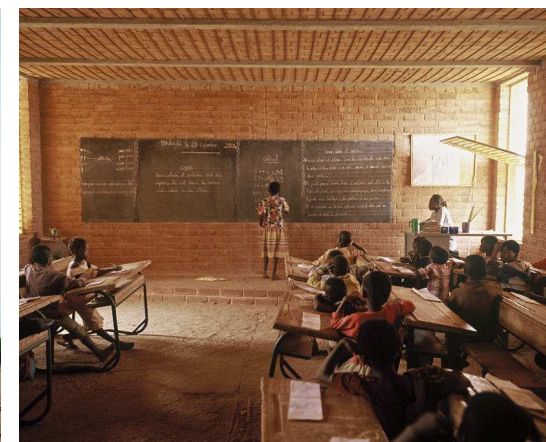
Izvor: https://en.wikipedia.org/wiki/Embodied_energy

Materijal	MJ/kg	Materijal	MJ/kg	Materijal	MJ/kg	Materijal	MJ/kg
Čelik	20,1	Armirani beton	1,9	Drvo sušeno na zraku	0,5	Glineni crijep	6,5
Aluminij	155	Opeka	2,5	Cementni mort (1:3)	1,33	Bale slame	0,91

SOCIJALNI ASPEKTI?

Izvor:

https://www.moma.org/interactives/exhibitions/2010/smallscalebigchange/projects/primary_school.html



GRADILIŠTE

Primjer – Terminal Franjo Tuđman - Bouygues



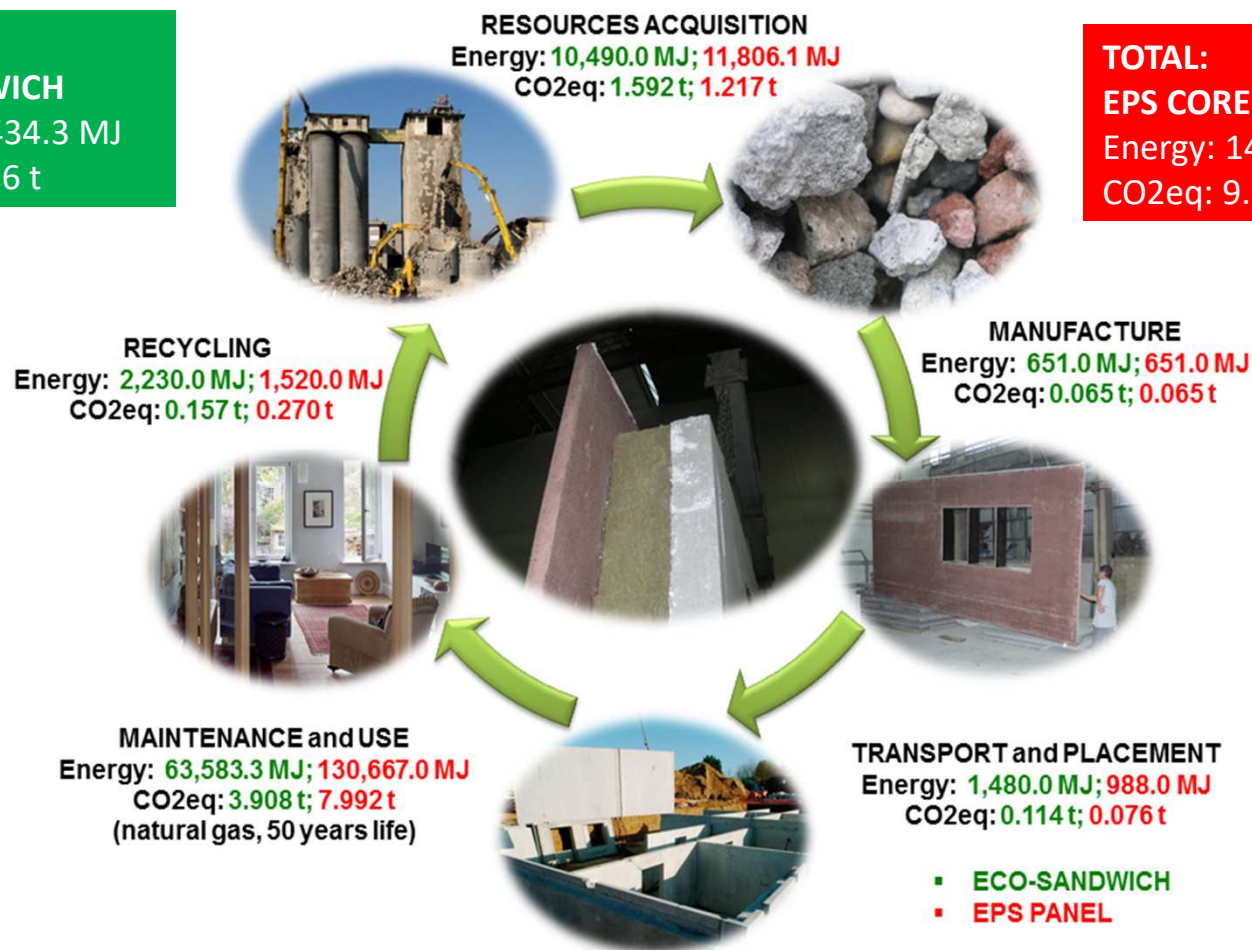
Primjer – Terminal Franjo Tuđman - Bouygues



PRIMJER LCA

Rezultati LCA analize

TOTAL:
ECO-SANDWICH
Energy: 78,434.3 MJ
CO₂eq: 5.836 t



TOTAL:
EPS CORE
Energy: 145,632.1 MJ
CO₂eq: 9.620 t

U životnom ciklusu od 50 godina

- Smanjenje korištenja energije za 46%
- Smanjenje emisije CO₂eq plinova za 39%

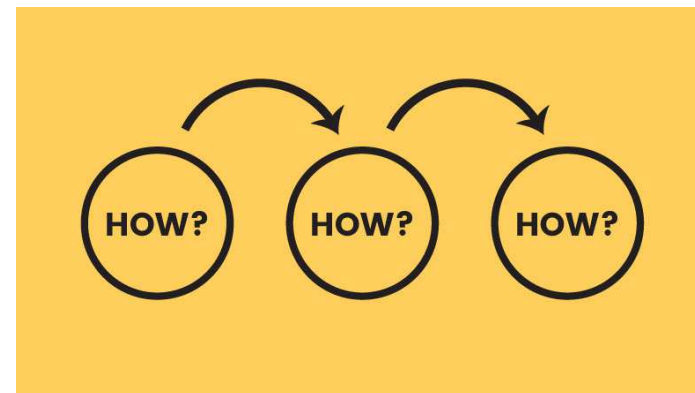
Projekt je sufinancirala Europska unija iz Europskog socijalnog fonda.

CPD4GB

RAZVOJ PROFESIONALNIH KOMPETENCIJA
ZA ZELENU GRADNJU
CONTINUOUS PROFESSIONAL DEVELOPMENT
FOR GREEN BUILDING

Projektni zadatak...

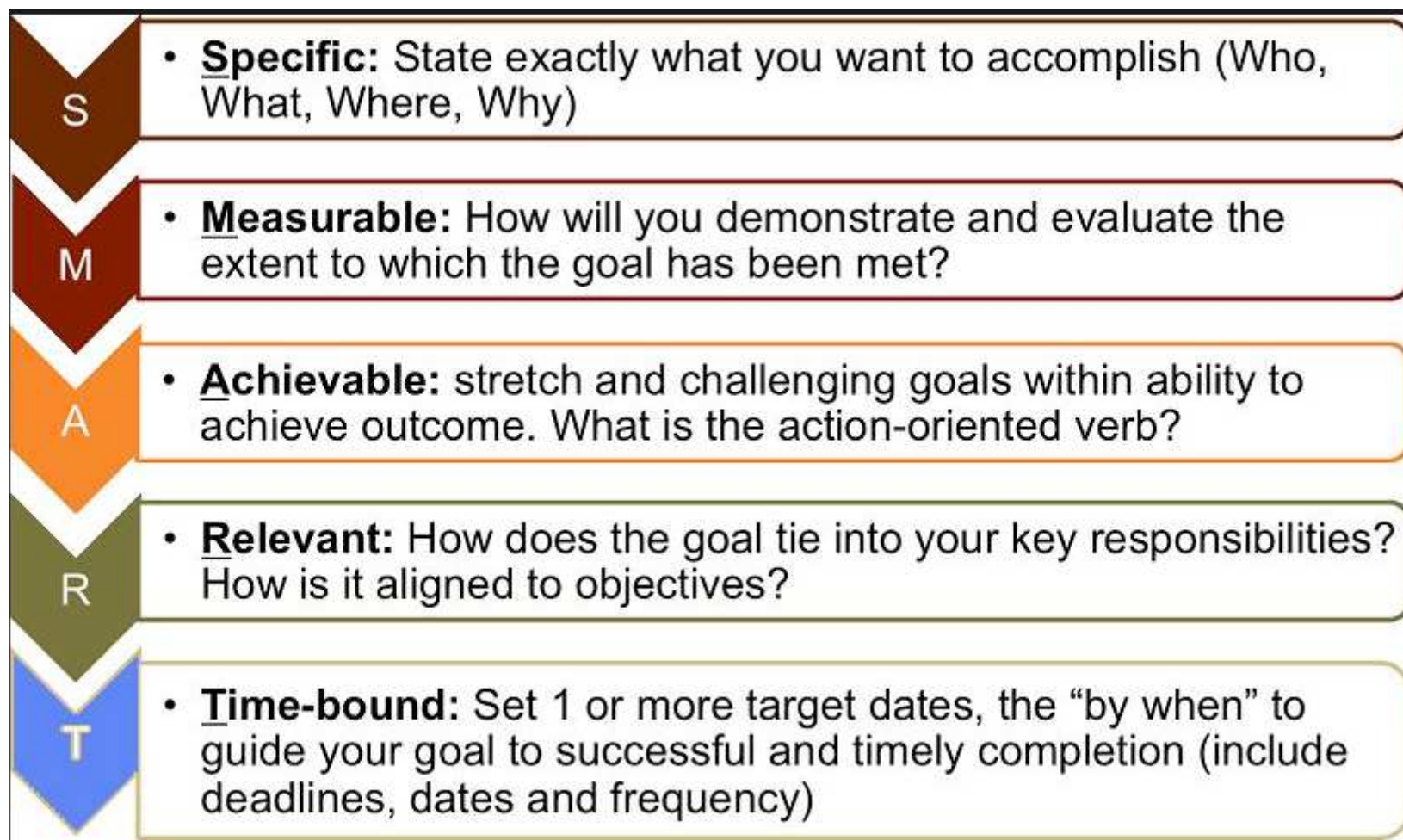
- Kvalitetna analiza i traženje optimuma u pogledu
 - Potrošnje energije s variranjem svih parametara u arhitektonsko-građevinskom, strojarskom i elektrotehničkom smislu
 - Odabir materijala i proizvoda s minimalnim utjecajem na okoliš
- Traženje globalnog optimuma...
 - ogroman broj kombinacija i mogućnosti!
- Je li put korištenje BIM-a!



ECOLOGICAL

Zapamtite!!!

BE SMART



HVALA!

bmilovanovic@grad.hr