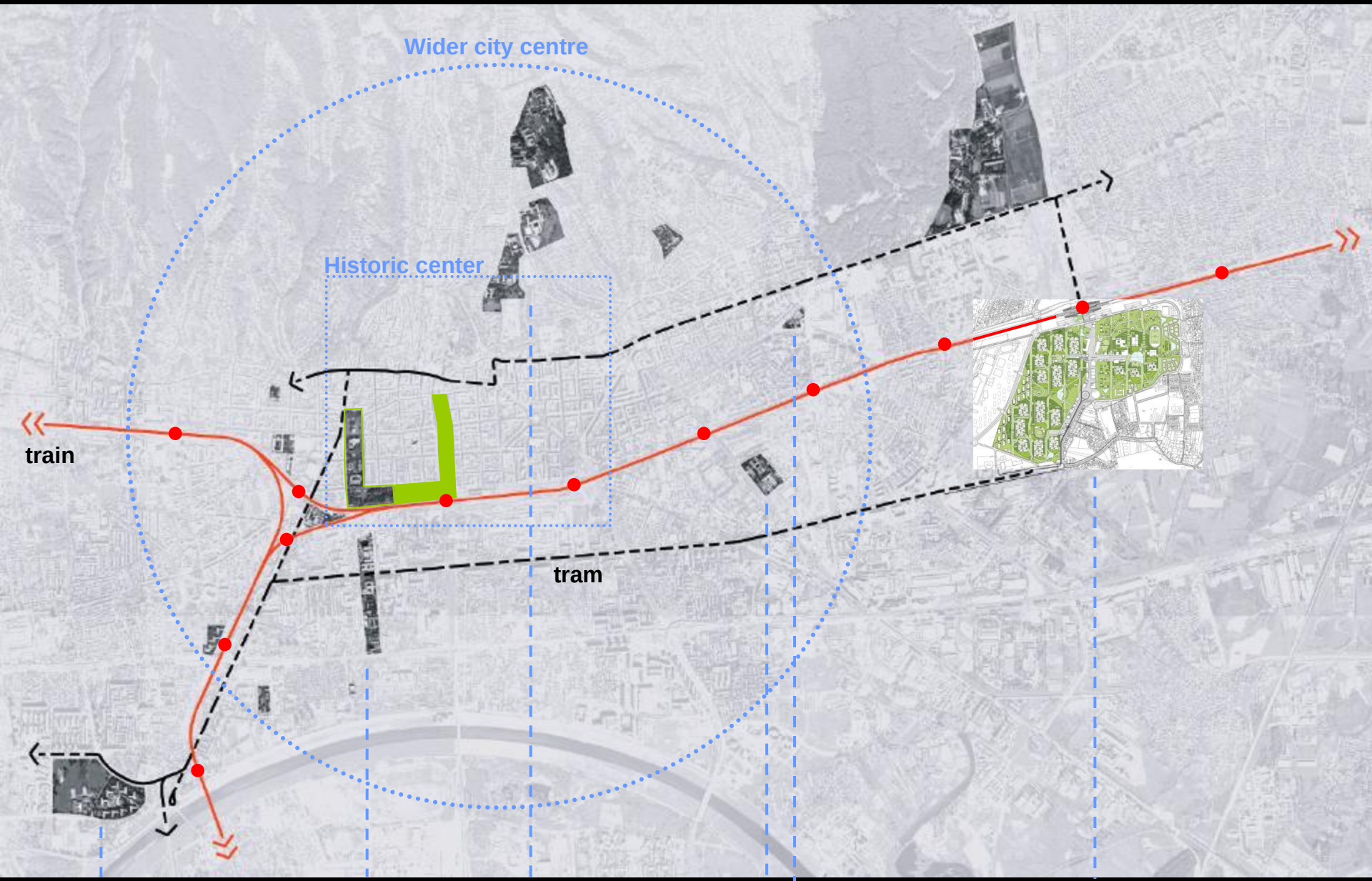
Prof. Bojan Baletic, PhD
Vice rector
University of Zagreb

Campus Borongaj

A CO2 Challenge for the University

Zagreb
15.05.2013.

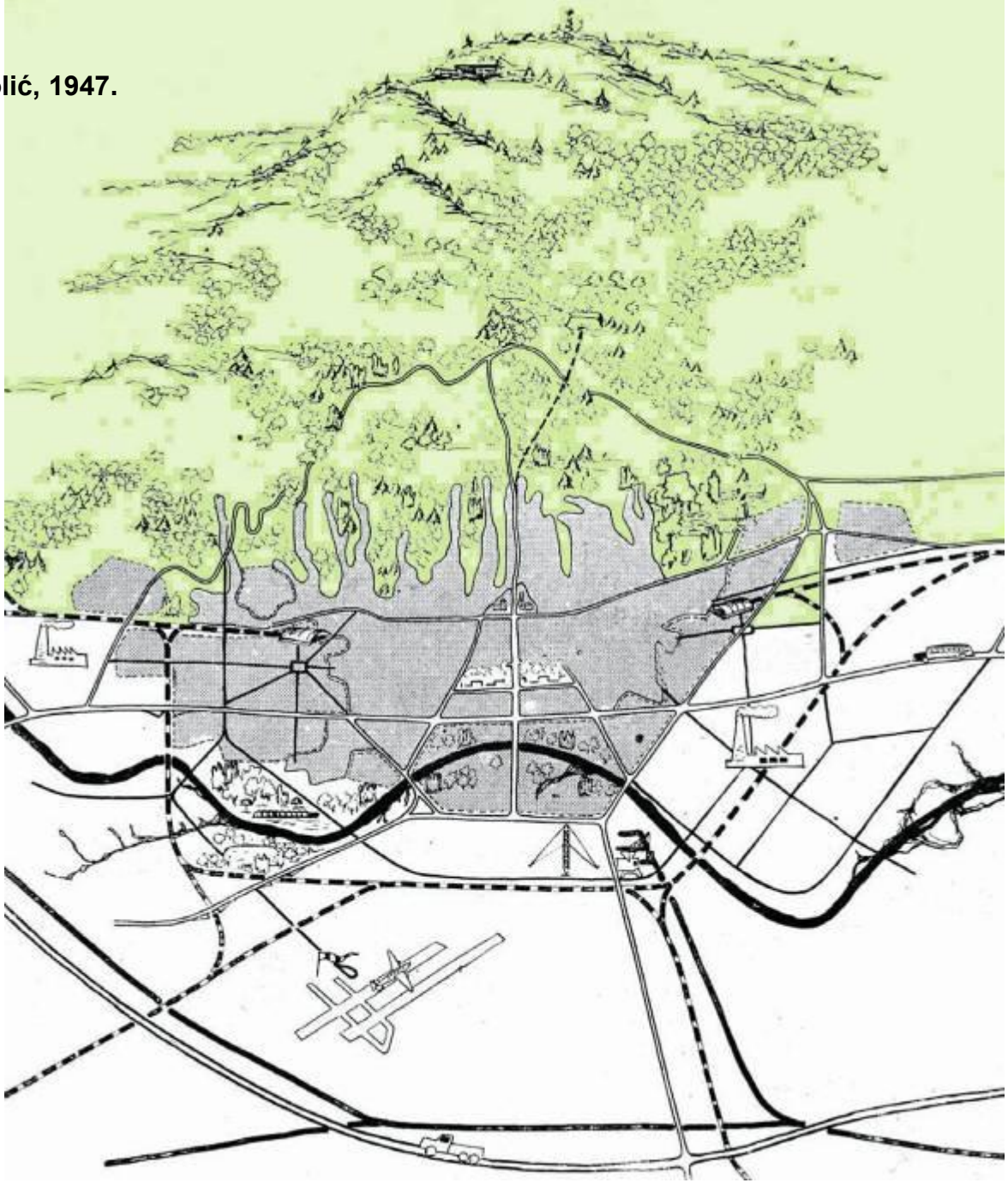
Campus and the City of Zagreb



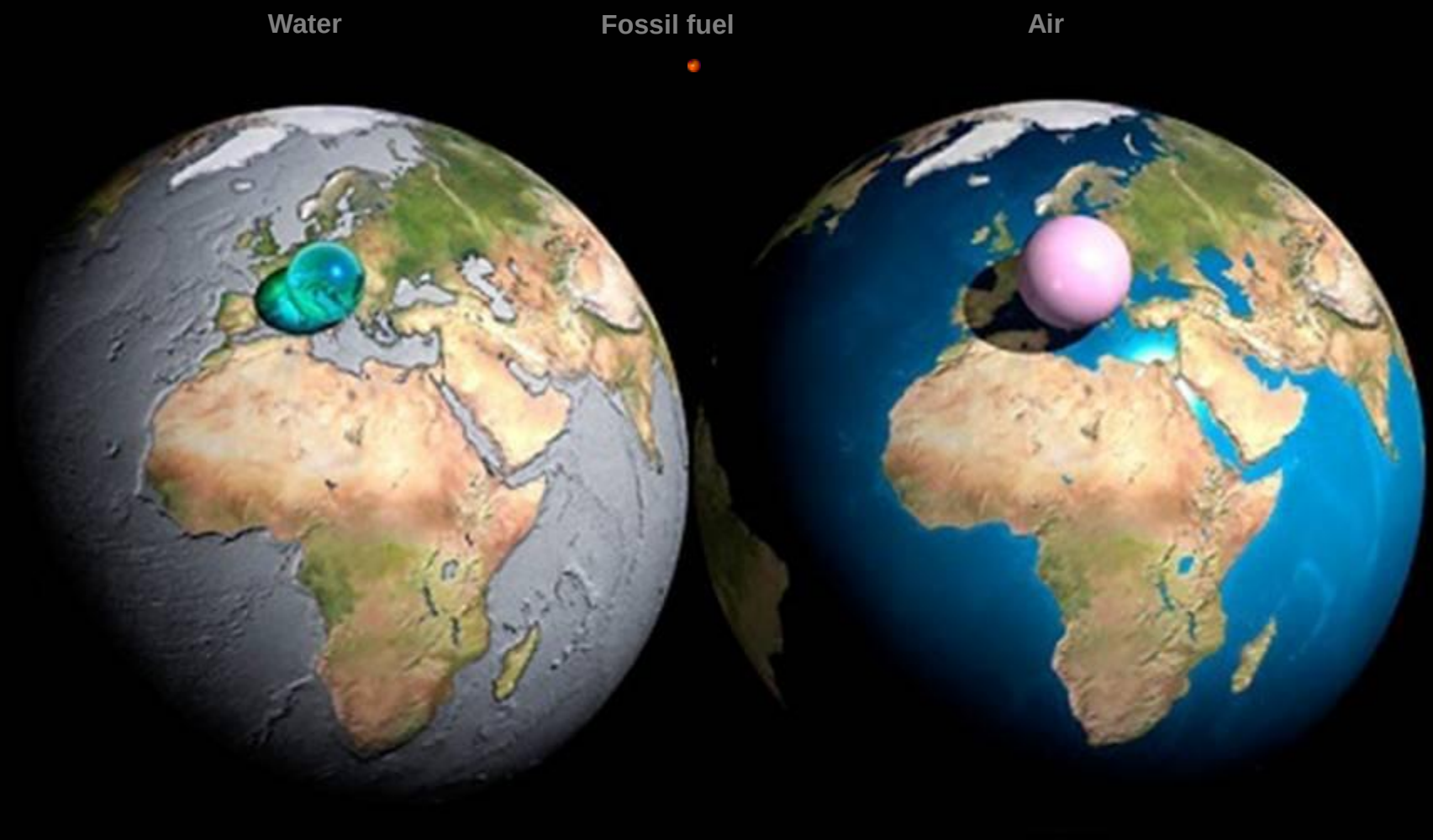

A Green City

“Green fingers”

Architect Vladimir Antolić, 1947.



Our Environment



Challenge 1_Use of Renewable Energy

Solar energy

89,000 TW

Wind energy

370 TW

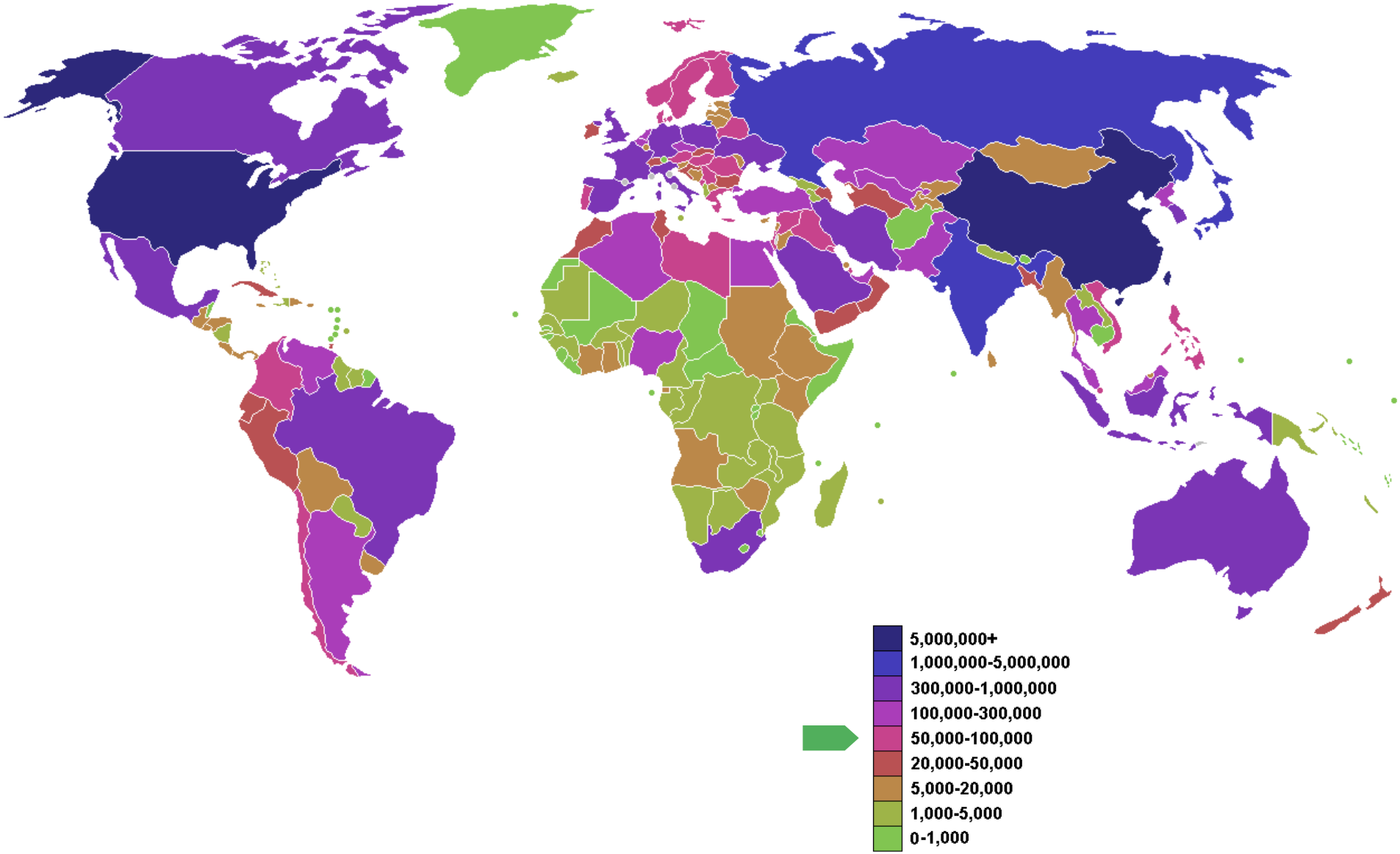
Geothermal energy

32 TW

Global consumption

15 TW

Challenge 2_Reduction of CO_2 emission



Consumption and emission per inhabitant

Ecological footprint [ha/in]
Electrical ene. use [MWh/in]
Oil consumption [liters/day]
CO2 emission [tons/in]

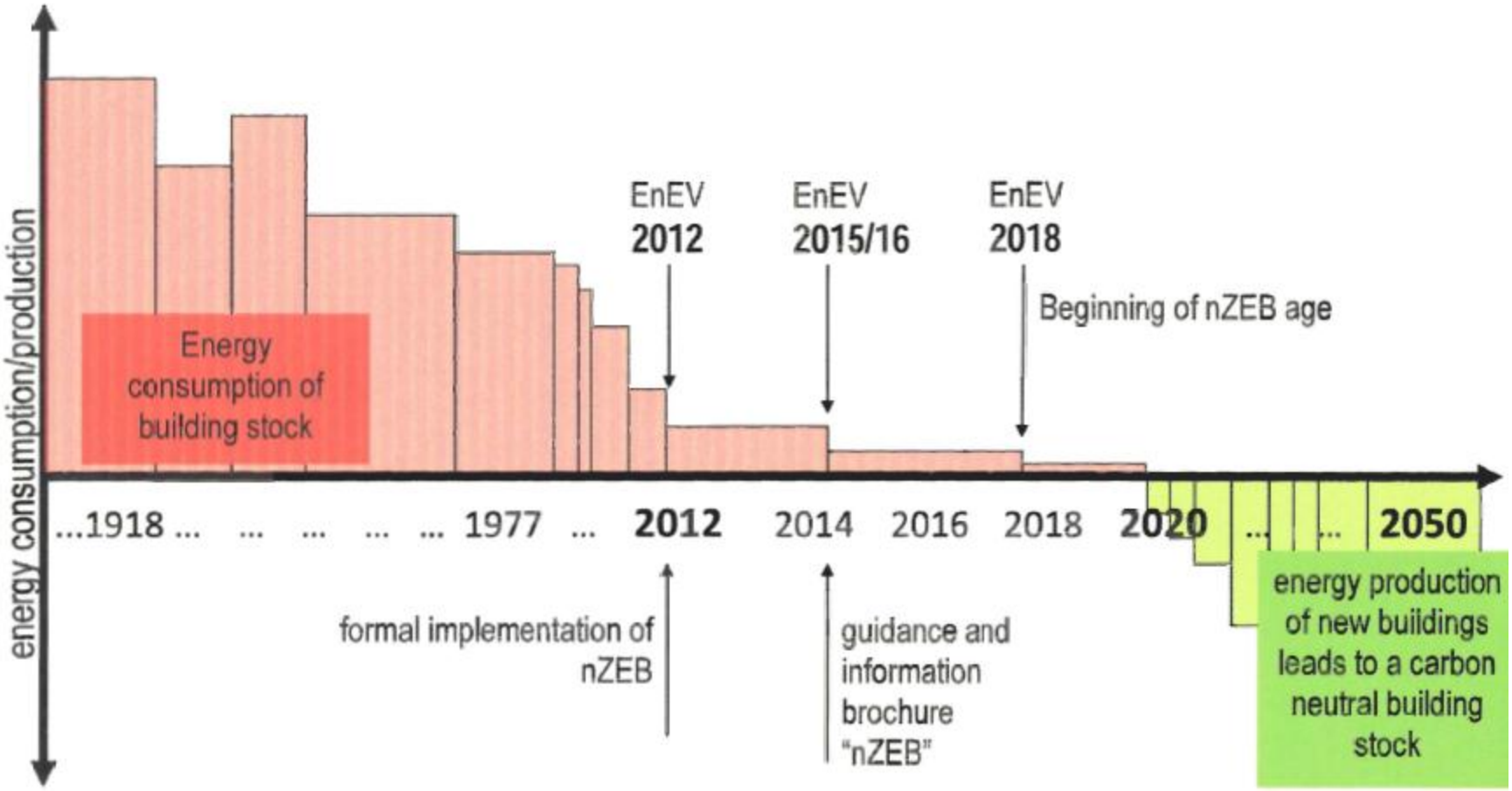
Reduction of demand → **system optimisation** → **renewable substance**

30
25
20
15
10
5
0

United Arab Emirates
United States of America
Germany
Croatia
Masdar

Source: Transolar

Roadmap to a carbon neutral building stock



JEREMY RIFKIN: THE THIRD INDUSTRIAL REVOLUTION (2011)

- **Five pillars:**
  - **Shifting to renewable energy**
  - **Transforming the building stock into micro power plants**
  - **Storage technologies in every building**
  - **Using Internet technologies to transform the power grid**
  - **Transitioning the transport fleet to plug-in and fuel cell vehicles**

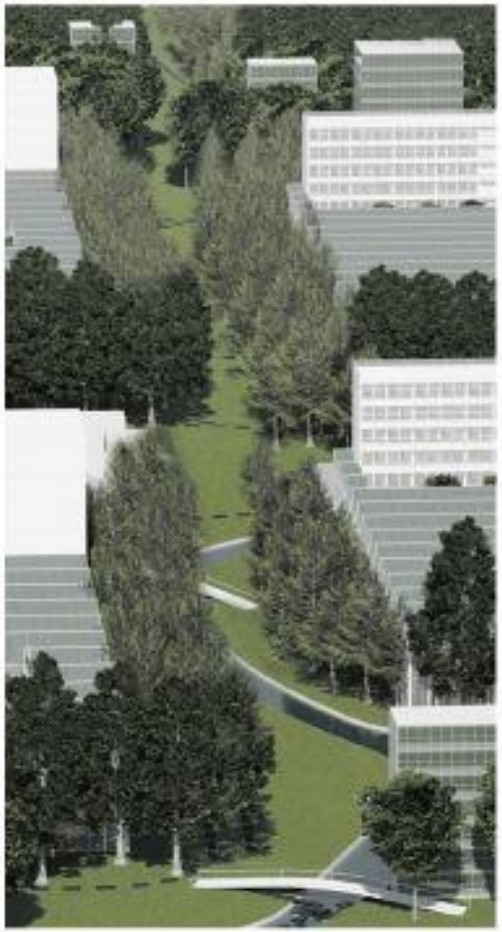
CAMPUS BORONGAJ - GREEN CAMPUS (2008)

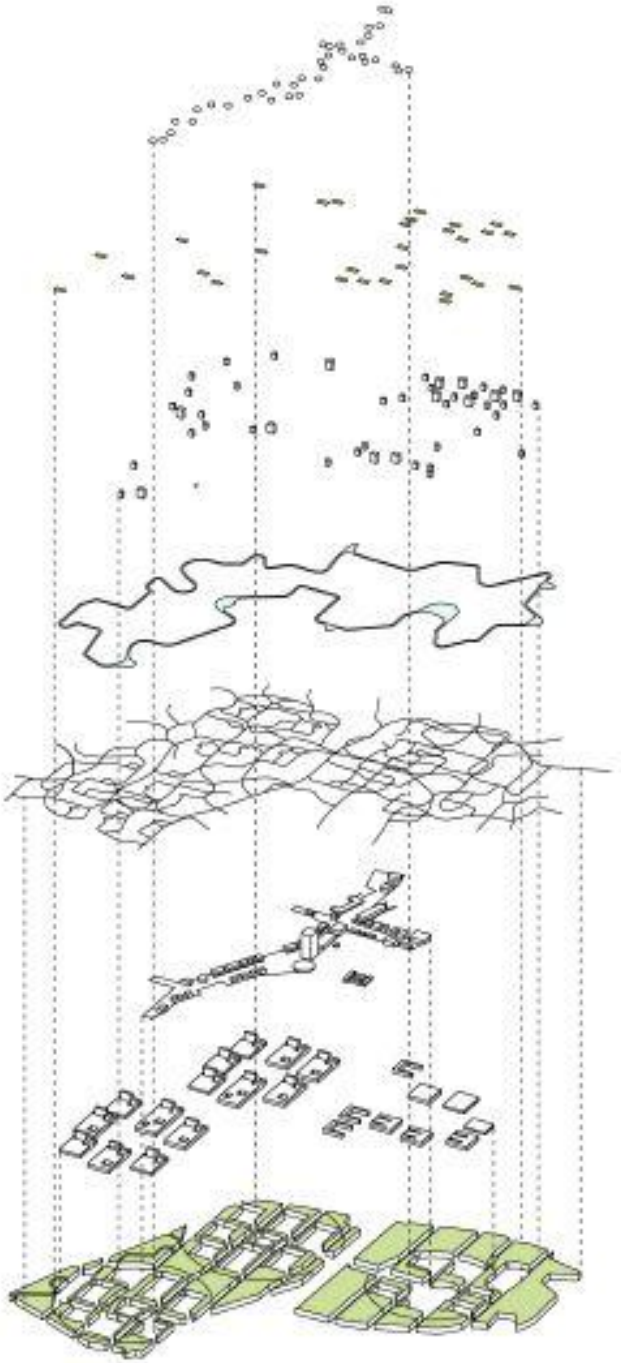
- **Use of renewable energy sources**
  - **Biomass energy**
  - **Geothermal energy**
  - **Solar energy**
- **Within campus only zero CO2 vehicles**
- **Treatment of all waste water**
- **Buildings CO2- (minus)**
- **Campus = City Innovation park – Extensive green areas (ISCN guidelines)**
- **Living laboratory on the use of renewable energy sources and technologies**

Campus Borongaj_view from south

Layered composition

How to make it interesting?

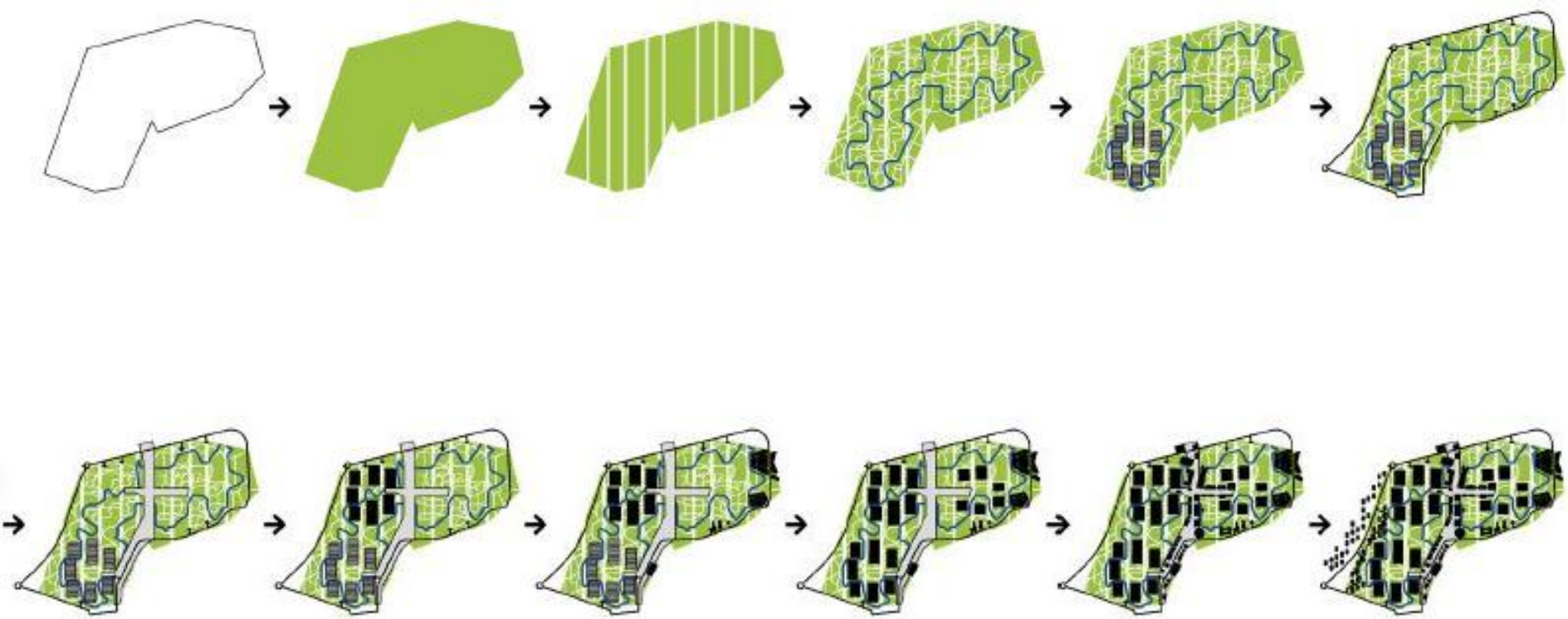




Campus plan

Scenario of urban development

How to develop the main idea through a longer period?



Wind corridor for the building
free cooling - summer night

Clusters orientation – south /north
to maximize passive heating and sun
energy harvesting by PV and Solar
collectors

Winter wind barrier - evergreen threes
-existing - *Picea abies*, *Taxus baccata*,
Pinus sp., *Pseudofsuga* sp.
-new - Pinus nigra, Thuja columnaris,
-Juniperus communis „Hibernica"

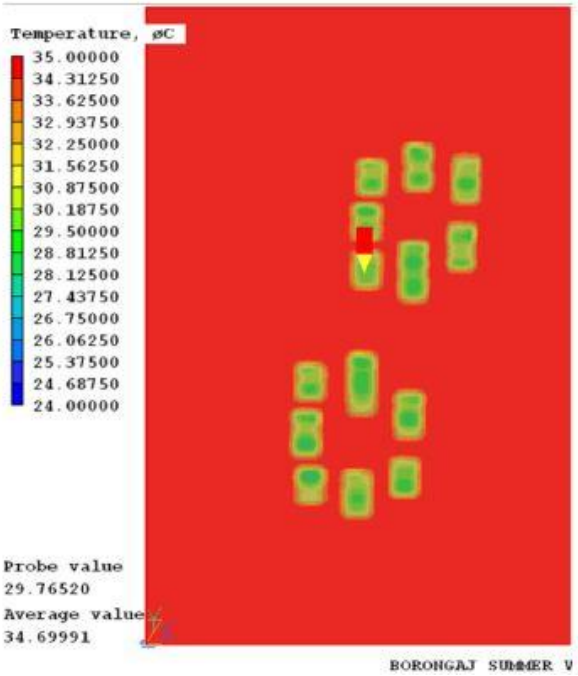
Semi open space - for social activities
central zone threes - high treetop(3-4m)
- *Celtis Australis*, *Rhustiphina*, *Betula verrucosa*

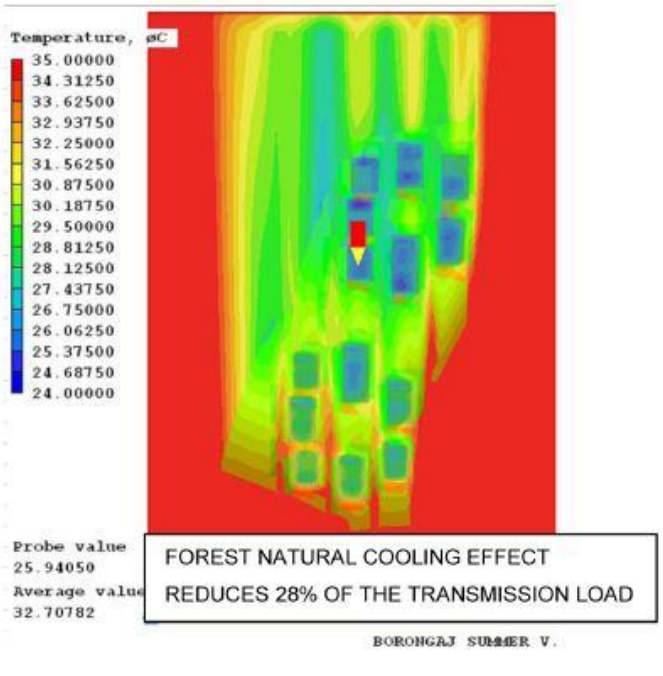
Passive heating - threes that loose leafs first
week in October
- *Acer platanoides*, *Alnus glutinosa*,

Urban adiabatic cooling – particular selection
of deciduous threes with high leaf surface area
- existing - *Carpinus Betulus*, *Catalpa bignonioides*, *Acer*
sp., *Juglans nigra*, *Platanus* sp
- new - Liqiudambar sp.

Wind corridor for the urban adiabatic
cooling - summer day

Bioclimatic strategy


Temperature, øC
35.00000
34.31250
33.62500
32.93750
32.25000
31.56250
30.87500
30.18750
29.50000
28.81250
28.12500
27.43750
26.75000
26.06250
25.37500
24.68750
24.00000
Probe value
29.76520
Average value
34.69991
BORONGAJ SUMMER V


Temperature, øC
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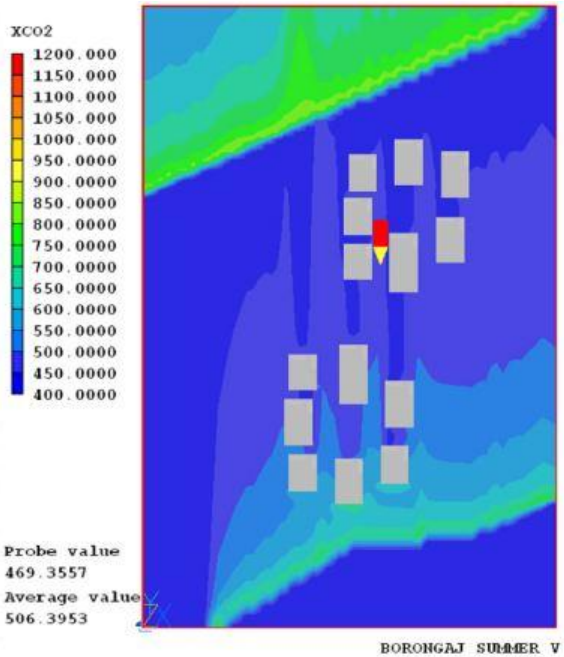
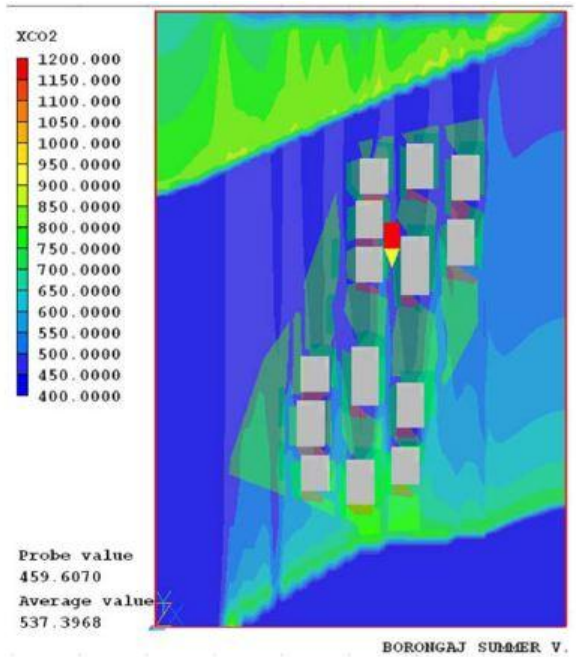
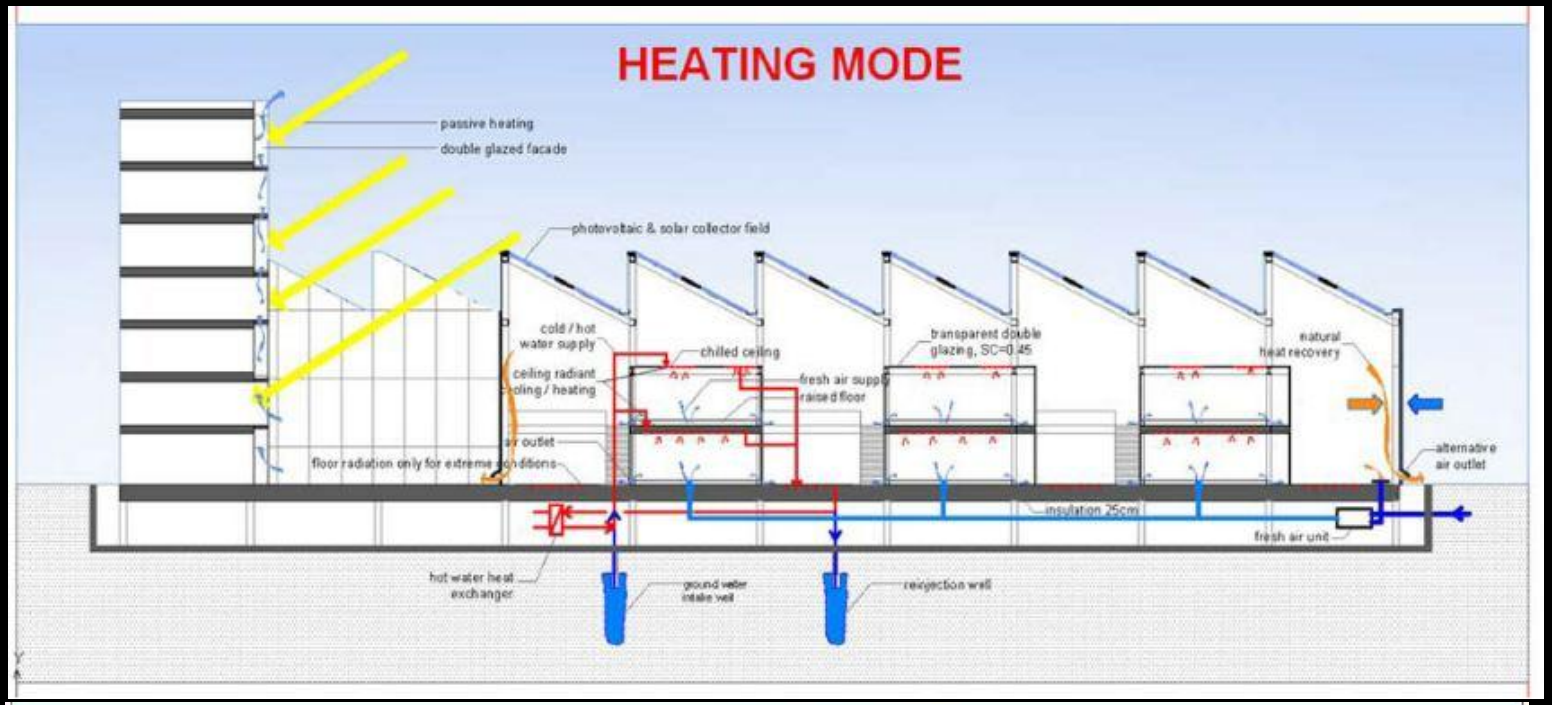
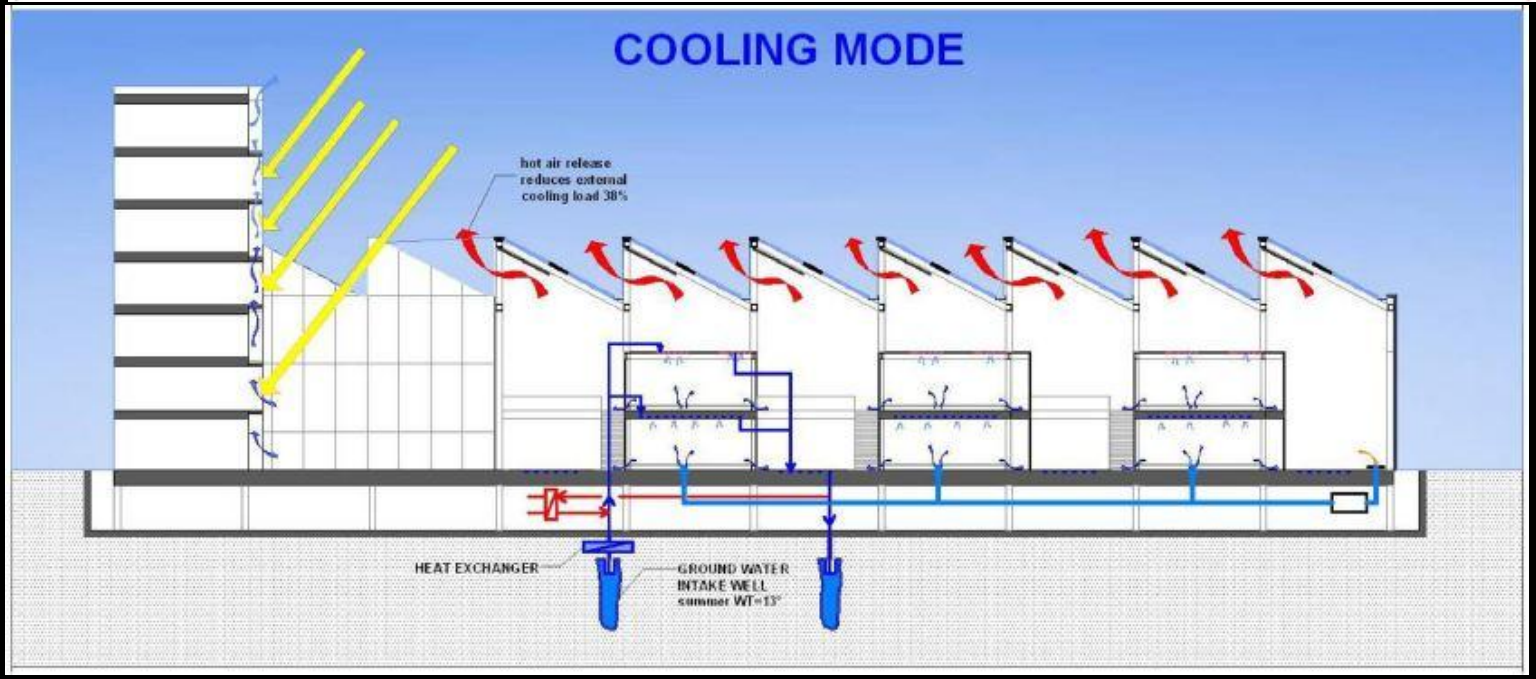
34.31250
33.62500
32.93750
32.25000
31.56250
30.87500
30.18750
29.50000
28.81250
28.12500
27.43750
26.75000
26.06250
25.37500
24.68750
24.00000
Probe value
25.94050
Average value
32.70782
FOREST NATURAL COOLING EFFECT
REDUCES 28% OF THE TRANSMISSION LOAD
BORONGAJ SUMMER V.


XCO2
1200.000
1150.000
1100.000
1050.000
1000.000
950.0000
900.0000
850.0000
800.0000
750.0000
700.0000
650.0000
600.0000
550.0000
500.0000
450.0000
400.0000
Probe value
469.3557
Average value
506.3953
BORONGAJ SUMMER V


XCO2
1200.000
1150.000
1100.000
1050.000
1000.000
950.0000
900.0000
850.0000
800.0000
750.0000
700.0000
650.0000
600.0000
550.0000
500.0000
450.0000
400.0000
Probe value
459.6070
Average value
537.3968
BORONGAJ SUMMER V.


HEATING MODE
passive heating
double glazed facade
photovoltaic & solar collector field
cold / hot water supply
chilled ceiling
transparent double glazing, SC=0.45
natural heat recovery
ceiling radiant cooling / heating
fresh air supply
raised floor
air outlet
floor radiation only for extreme conditions
alternative air outlet
insulation 25cm
fresh air unit
hot water heat exchanger
ground water intake well
reinjection well


COOLING MODE
hot air release reduces external cooling load 38%
HEAT EXCHANGER
GROUND WATER INTAKE WELL summer WT=13°

The rating class of solution according to the energy certificate of buildings in Croatia.

ENERGETSKI CERTIFIKAT NESTAMBENE ZGRADE (PRVA STRANICA)

prema Direktivi 2002/91/EC

Energetski certifikat za nestambene zgrade

Zgrada	[x] nova	[ ] postojeća
Vrsta zgrade	Nestambena	
K.č. k.o.	ZAGREB BORONGAJ	
Adresa	-	
Mjesto	ZAGREB - BORONGAJ	
Vlasnik/Investitor	SVEUCILISTE U ZAGREBU	
Izvođač		
Godina izgradnje		

$Q_{H,nd,rel}$	%	Izračun 22,2
A+	≤ 15	
A	≤ 25	A
B	≤ 50	
C	≤ 100	
D	≤ 150	
E	≤ 200	
F	≤ 250	
G	> 250	

Podaci o osobi koja je izdala energetski certifikat	
Ovlaštena fizička osoba	
Ovlaštena pravna osoba	
Imenovana osoba	
Registarski broj ovlaštene osobe	
Broj energetskog certifikata	
Datum izdavanja/rok važenja	
Potpis	

Podaci o zgradi	
A_k [m²]	10.588
V_e [m³]	43.411
f_0 [m⁻¹]	0,4
$H_{T,ref}$ [W/(m²K)]	0,95
$Q''_{H,nd,ref}$ [kWh/(m²a)]	65,6

THE EVALUATION PROCESS IS BASED ON HEATING, FINAL ENERGY, NOT PRIMARY ENERGY.

The rating class of solution according to energy certificate of buildings in EU (Germany)

ENERGIEAUSWEIS für Nichtwohngebäude

gemäß den §§ 16 ff. Energieeinsparverordnung (EnEV)

Berechneter Energiebedarf des Gebäudes — Adresse, Gebäudeteil — 2

Primärenergiebedarf „Gesamtenergieeffizienz"

CO_2-Emissionen [1] kg/(m²·a)

Dieses Gebäude: kWh/(m²·a)

0 100 200 300 400 500 600 700 800 900 ≥1000

EnEV-Anforderungswert Neubau (Vergleichswert)

EnEV-Anforderungswert modernisierter Altbau (Vergleichswert)

Anforderungen gemäß EnEV [2]

Primärenergiebedarf

Ist-Wert kWh/(m²·a) Anforderungswert kWh/(m²·a)

Mittlere Wärmedurchgangskoeffizienten ☐ eingehalten

Sommerlicher Wärmeschutz (bei Neubau) ☐ eingehalten

Für Energiebedarfsberechnungen verwendetes Verfahren

☐ Verfahren nach Anlage 2 Nr. 2 EnEV

☐ Verfahren nach Anlage 2 Nr. 3 EnEV („Ein-Zonen-Modell")

☐ Vereinfachungen nach § 9 Abs. 2 EnEV

Endenergiebedarf

Energieträger	Heizung	Warmwasser	Eingebaute Beleuchtung	Lüftung [4]	Kühlung einschl. Befeuchtung	Gebäude insgesamt

Jährlicher Endenergiebedarf in kWh/(m²·a) für

Aufteilung Energiebedarf

[kWh/(m²·a)]	Heizung	Warmwasser	Eingebaute Beleuchtung	Lüftung [4]	Kühlung einschl. Befeuchtung	Gebäude insgesamt
Nutzenergie						
Endenergie						
Primärenergie						

Ersatzmaßnahmen [3]

Anforderungen nach § 7 Nr. 2 EEWärmeG

☐ Die um 15 % verschärften Anforderungswerte sind eingehalten.

Anforderungen nach § 7 Nr. 2 i. V. m. § 8 EEWärmeG

Die Anforderungswerte der EnEV sind um % verschärft.

Primärenergiebedarf

Verschärfter Anforderungswert kWh/(m²·a).

Wärmeschutzanforderungen

☐ Die verschärften Anforderungswerte sind eingehalten.

Gebäudezonen

Nr.	Zone	Fläche [m²]	Anteil [%]
1			
2			
3			
4			
5			
6			
☐	weitere Zonen in Anlage		

Erläuterungen zum Berechnungsverfahren

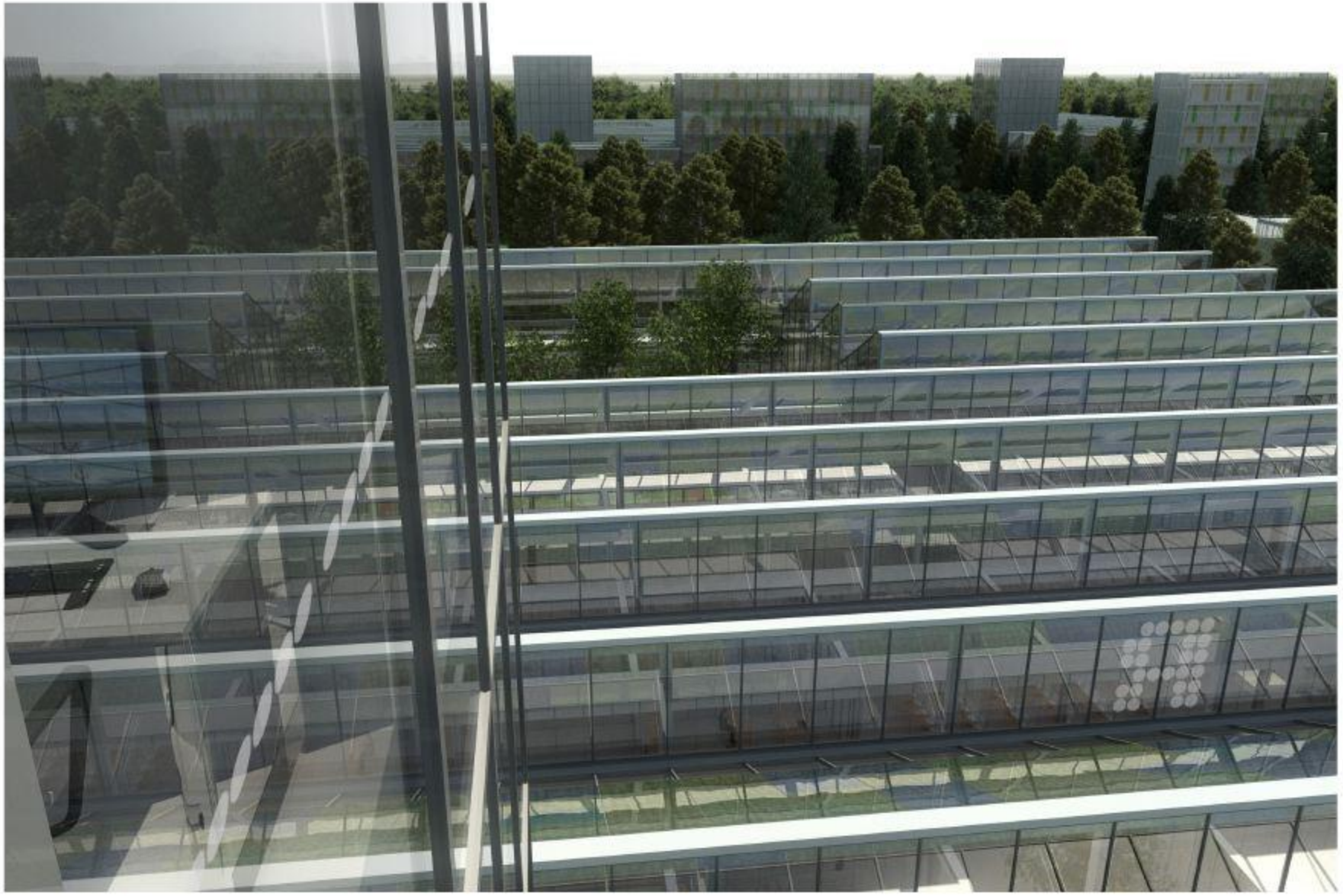
Die Energieeinsparverordnung lässt für die Berechnung des Energiebedarfs in vielen Fällen neben dem Berechnungsverfahren alternative Vereinfachungen zu, die im Einzelfall zu unterschiedlichen Ergebnissen führen können. Insbesondere wegen standardisierter Randbedingungen erlauben die angegebenen Werte keine Rückschlüsse auf den tatsächlichen Energieverbrauch. Die ausgewiesenen Bedarfswerte sind spezifische Werte nach der EnEV pro Quadratmeter beheizte / gekühlte Nettogrundfläche.

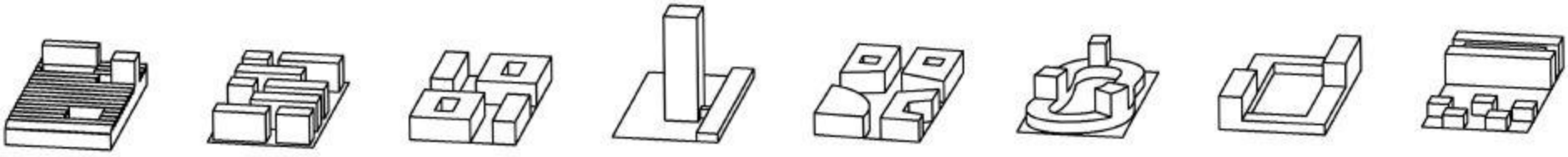
[1] freiwillige Angabe [2] bei Neubau sowie bei Modernisierung im Fall des § 16 Abs. 1 Satz 2 EnEV

[3] nur bei Neubau im Falle der Anwendung von § 7 Nr. 2 Erneuerbare-Energien-Wärmegesetz [4] nur Hilfsenergiebedarf

THE EVALUATION PROCESS IS BASED ON PRIMARY ENERGY, NOT FINAL ENERGY AND NOT ONLY IN HEATING, BUT BASED ON THE SUM IN HEATING, COOLING, SANITARY HOT WATER AND ELECTRICAL ENERGY FOR LIGHTING AND VENTILATION.

Faculty buildings





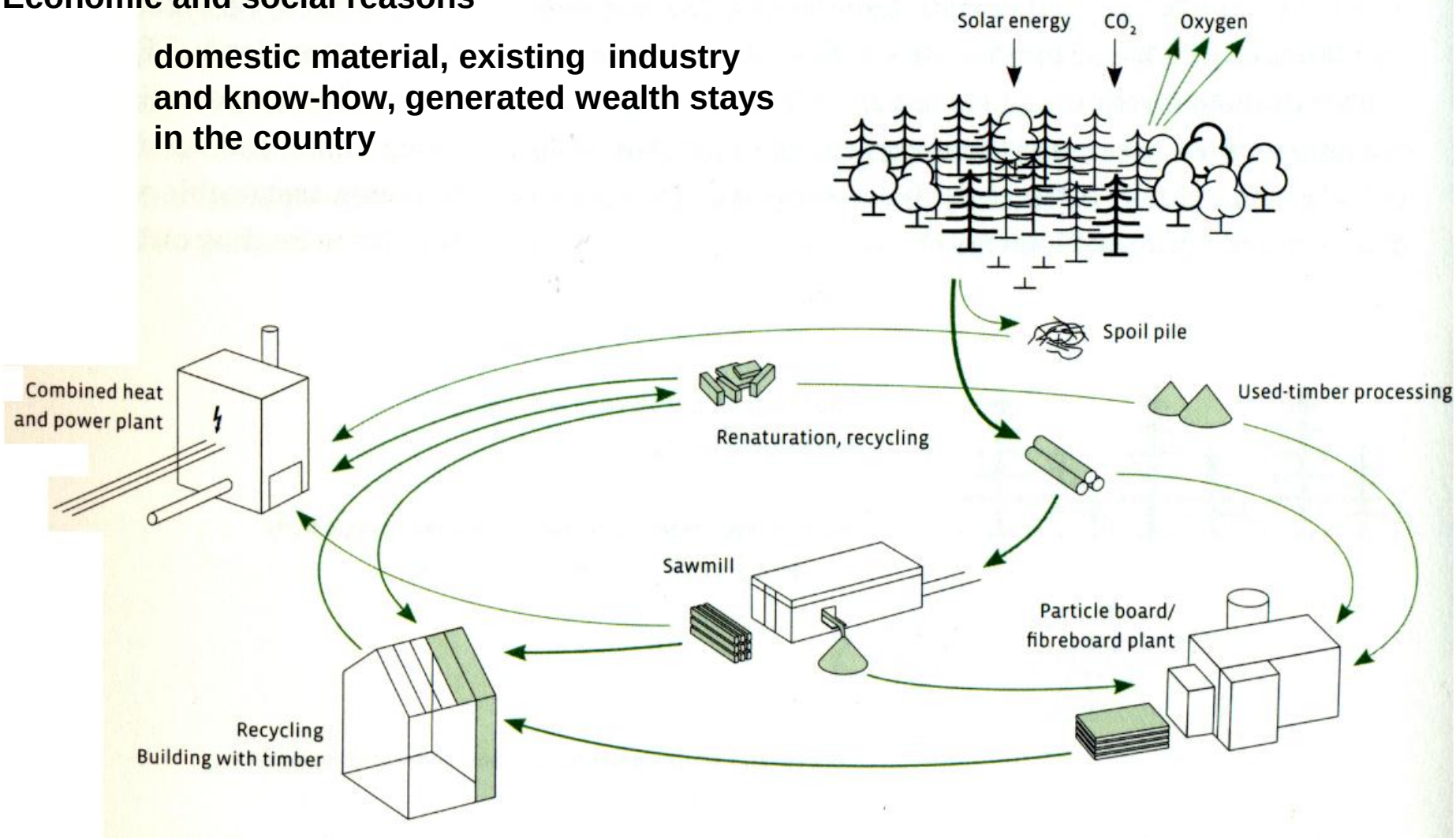
Why wood?

Ecological reasons

renewable material, recyclable material, CO2 container, aesthetic reasons

Economic and social reasons

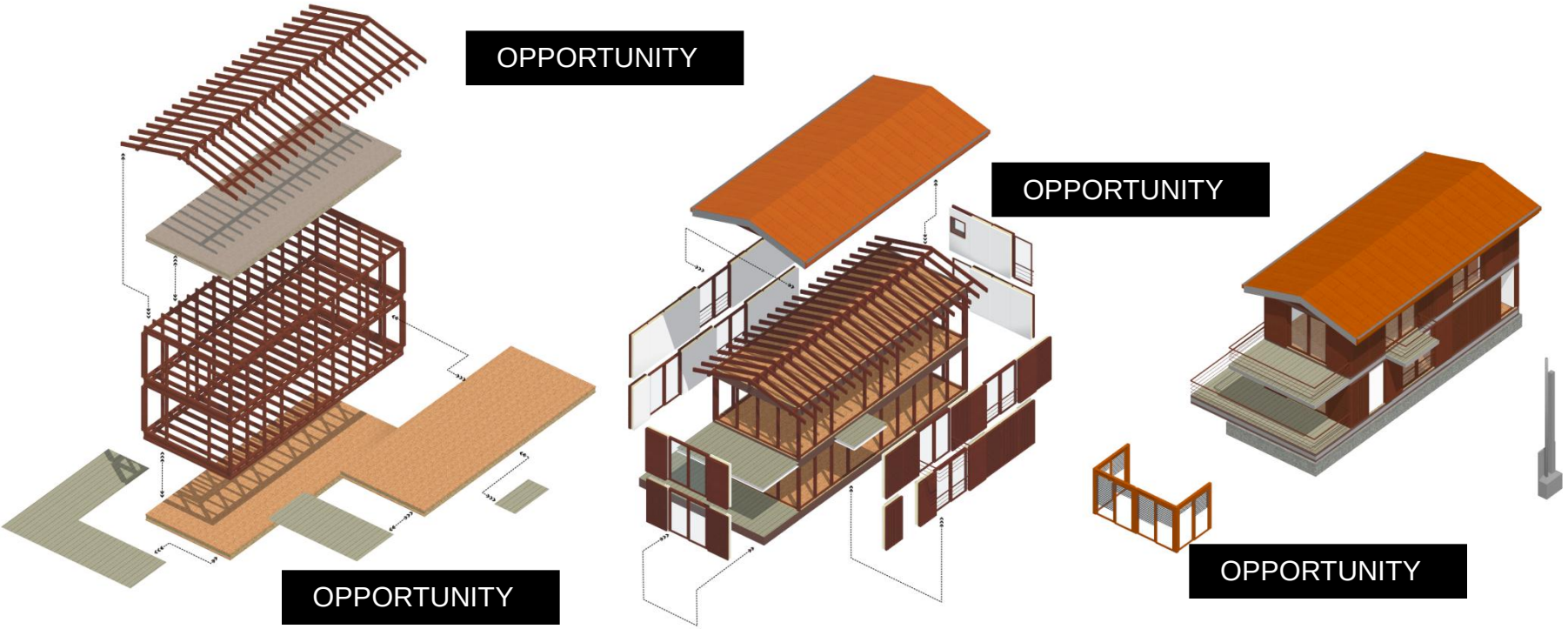
domestic material, existing industry and know-how, generated wealth stays in the country



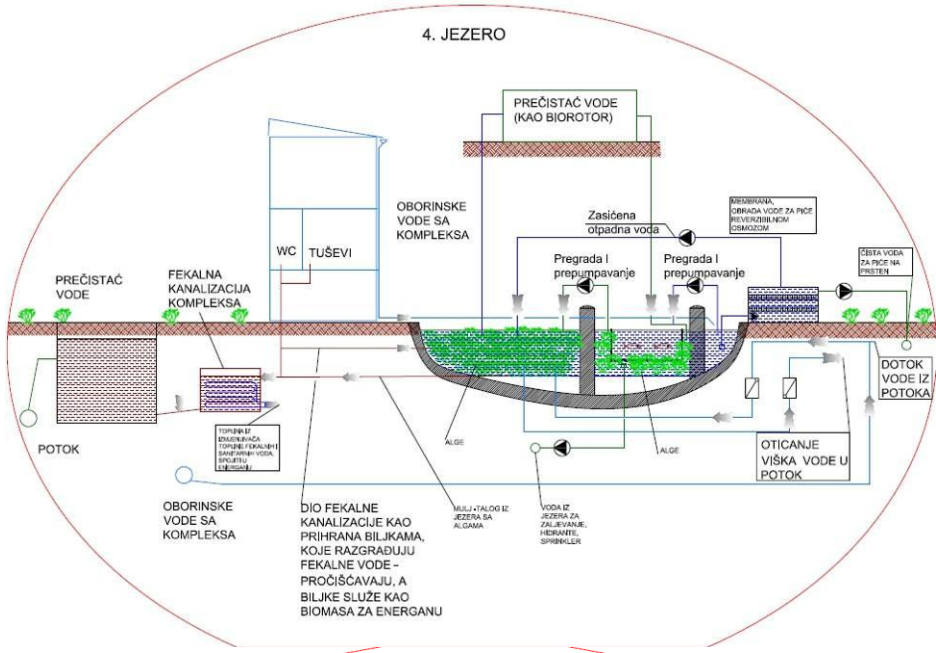
Modular structure – industrial prefabrication – Croatian know-how

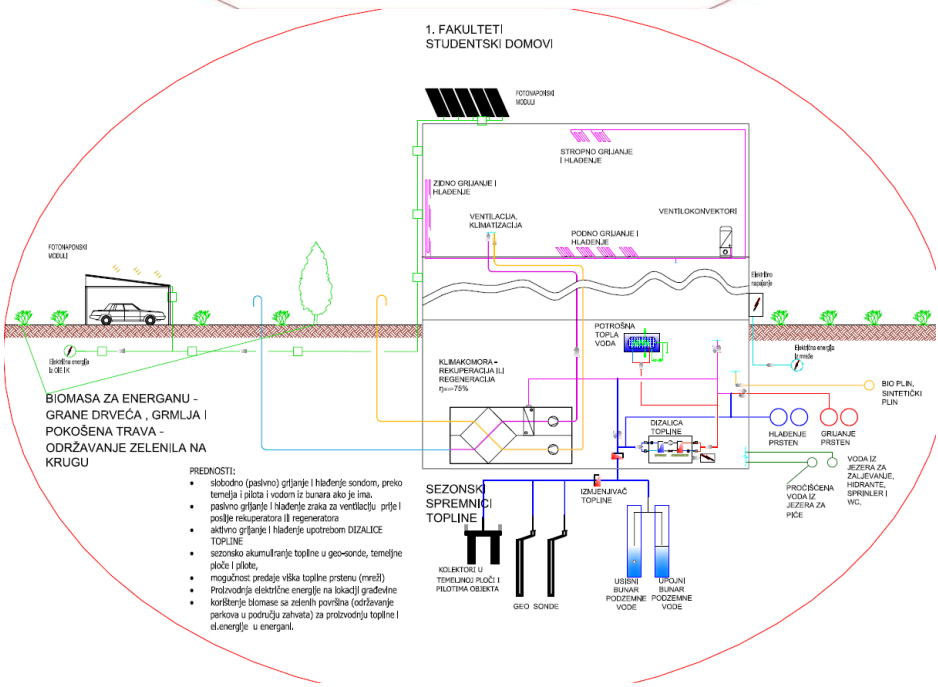
Construct a modular building of 2000m2 as a first pilot unit in technological park

Establish a Centre for Sustainable Building (reference point, repository, advice and guidance centre)

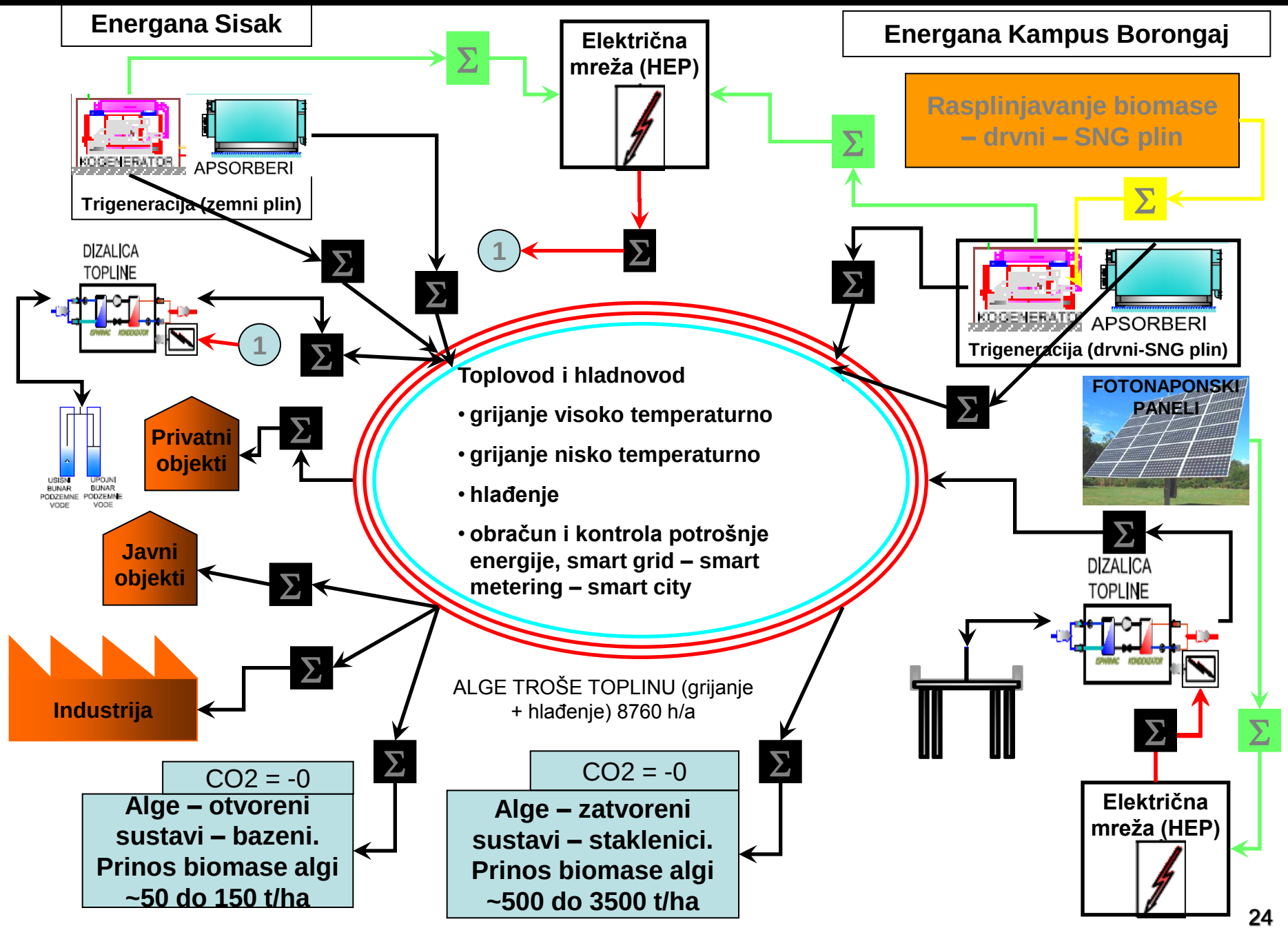


Campus Borongaj_summer and winter

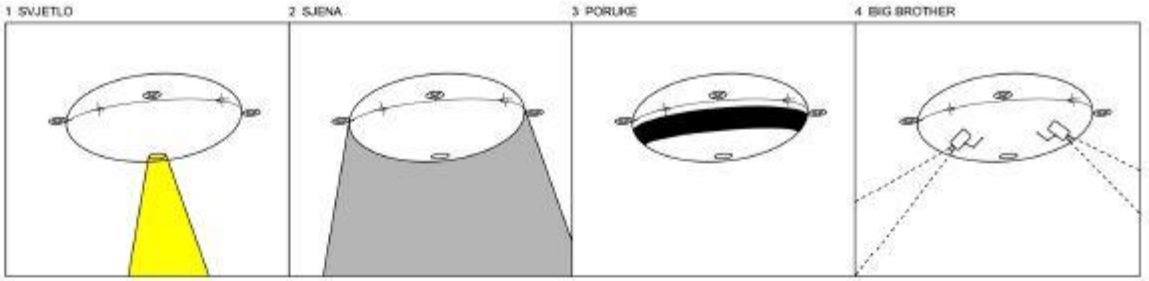




Campus Borongaj_overall energy concept



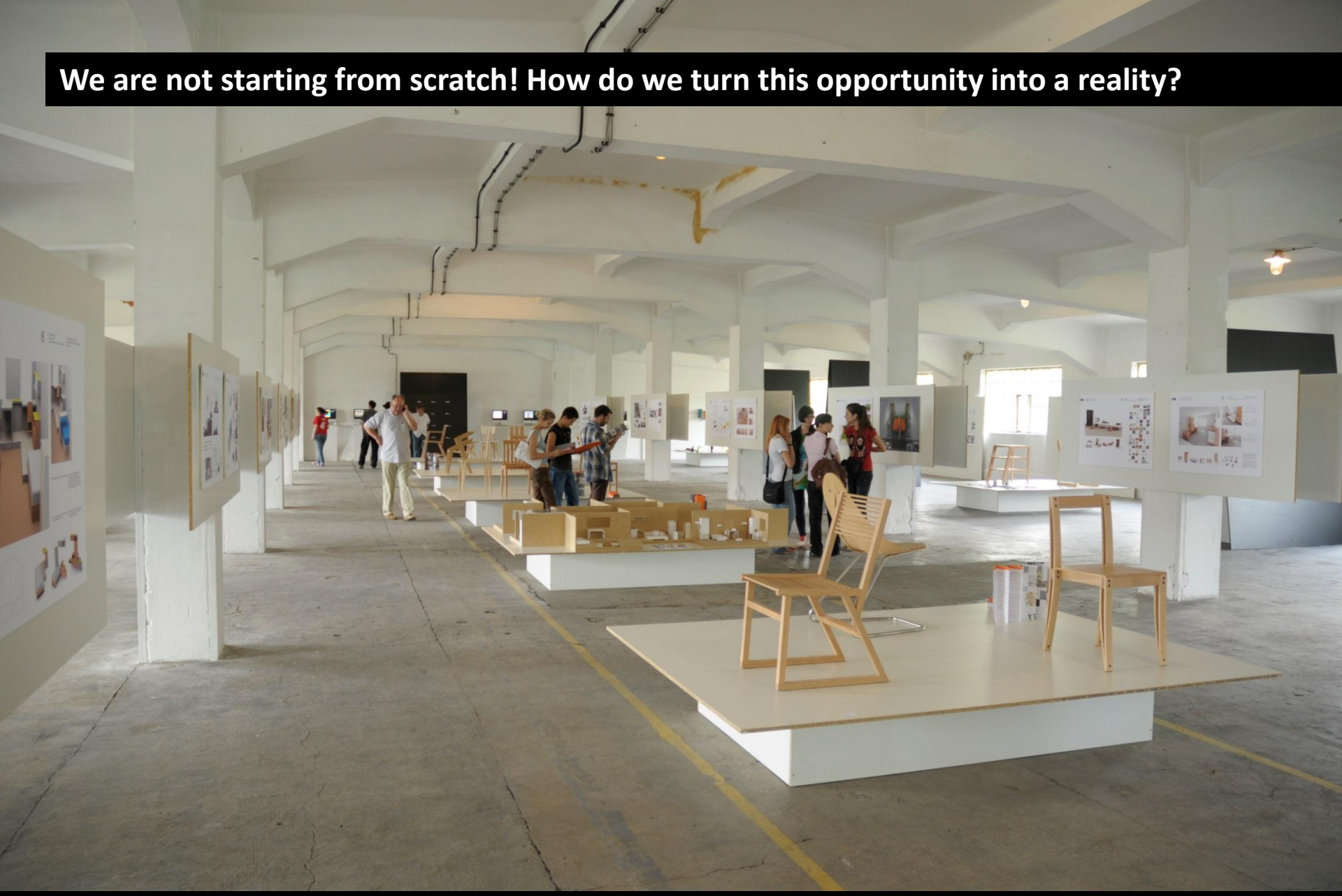
Kampus Borongaj_view from west



Campus Borongaj_Hyperspheres

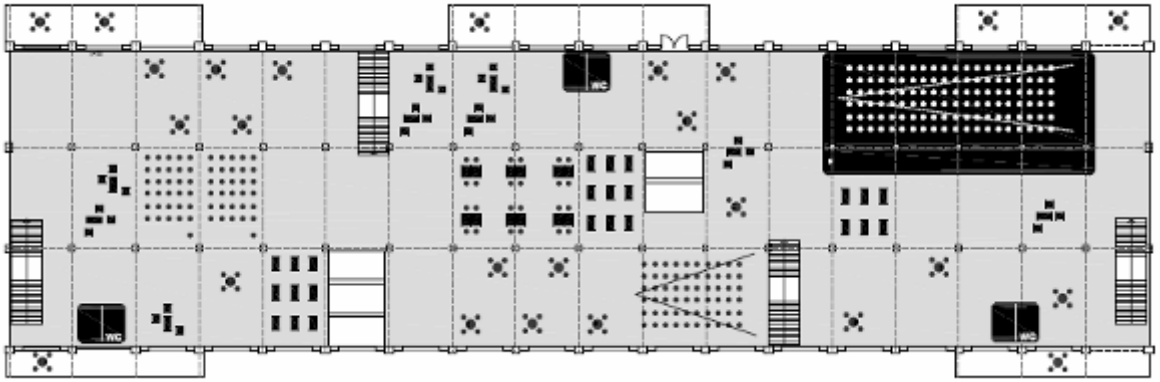
Urban gardening _ a program for Borongaj campus

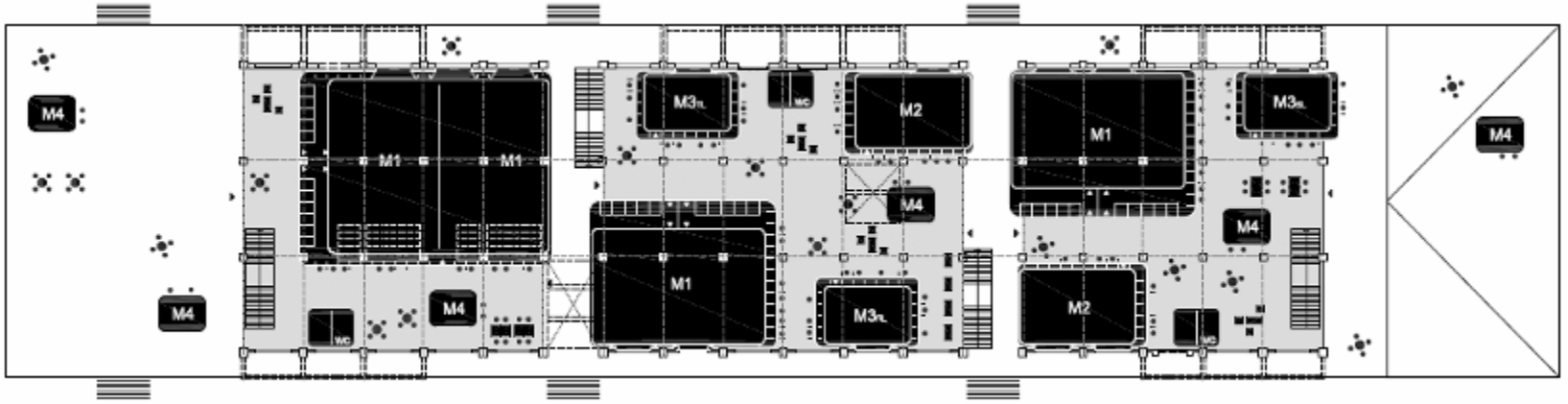
We are not starting from scratch! How do we turn this opportunity into a reality?

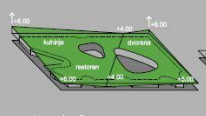


Exhibition of student works – Campus Borongaj, July 2009.

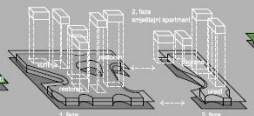
OBJEKT 37_CREATIVE INCUBATOR



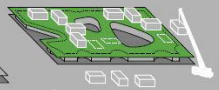




- ekonomizacija prostora
7. - lom krovne plohe



8. faznost izgradnje prema sadržajima

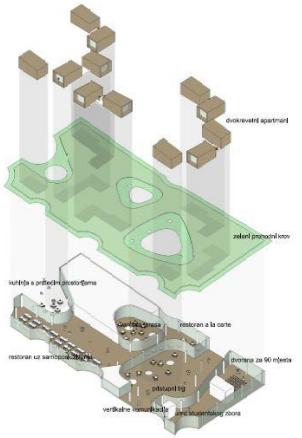


- montažna gradnja
9. - prefabricirani objekti na krovu

zeleni paviljon / restoran
rad br.04 / dorada
03

idejno arhitektonsko rješenje

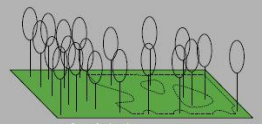
tlocrt kata
m 1/200



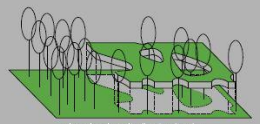
funkcionalna shema

3. postojeća stanje na parceli

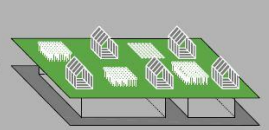
4. inspiracija



- čuvanje drveća
5. koncept - smještaj objekta između drveća



metoda - izrezivanje teritorija oko drveća
- formiranje novog tla u zraku

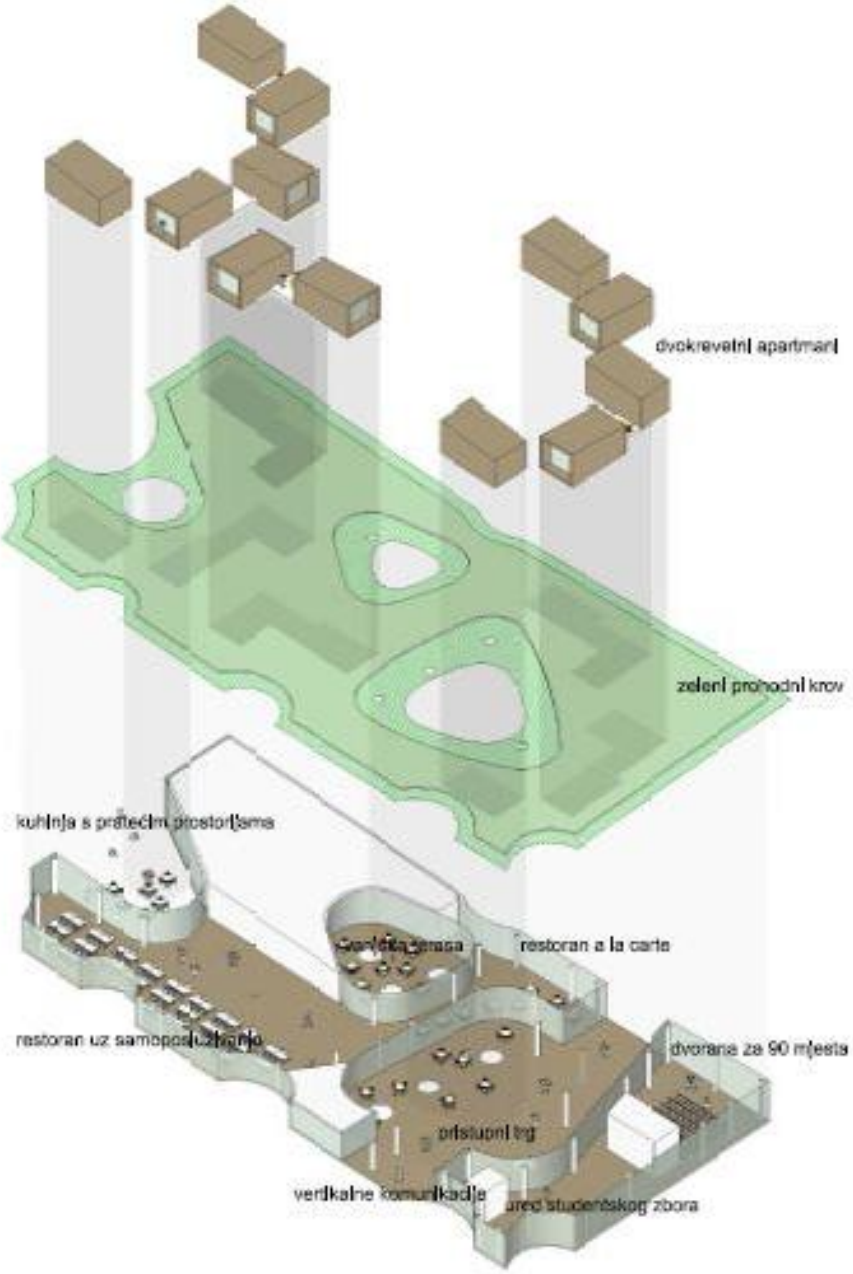


6. vrt na krovu

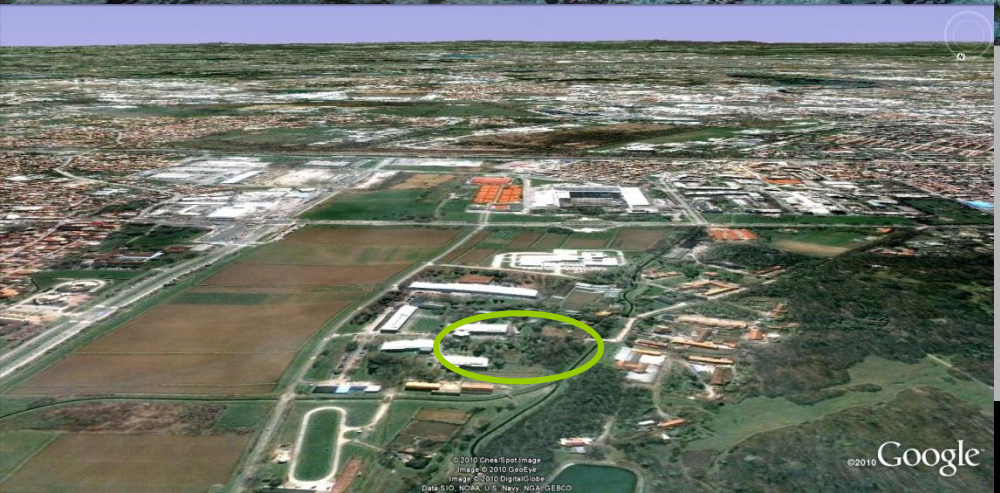
zeleni paviljon / restoran
rad br.04 / dorada
02

idejno arhitektonsko rješenje

tlocrt prizemlja
m 1/200



funkcionalna shema



zeleni paviljon / restoran

rad br.04 / dorada

09

Idejno arhitektonsko rješenje

prostorni prikazi

Campus Borongaj_view from north

Campus Borongaj is important for:

The University: new study and research experience, raised standards, optimized resources, living facilities, space for research and business collaboration, energy efficient architecture

The City: enhanced identity of university city, urban centre, traffic solutions, park, living laboratory for sustainability, urban attractions

The North-West region: support for development clusters, regional model of collaboration with Varaždin and Sisak

Croatia: development of green technologies, networking with entrepreneurial initiatives (Technopolis, Start up Croatia), promotion of Croatian higher education (among 3%)

The EU: A EU Living Lab, respectable university – reference point for central and south-east Europe, National Met office – Centre for Adriatic region weather