Sustainable Design *Principles*

Wednesdays 7.9. - 14.12. at 9.15-12.00 in U8

Professors Elisa Lähde, Toni Kotnik & Matti Kuittinen

Who we are?

Professor Elisa Lähde

Professor Toni Kotnik

Professor Matti Kuittinen

Schedule of the course

Computational cycles (prof. Toni Kotnik)	
12.10.	Performative Form
26.10.	Found Form
2.11.	Designed Form

Introduction	
7.9.	Introduction to the course (online)
14.9.	Guest lecture: Barnabas Calder (online)

Resource cycles (prof. Matti Kuittinen)	
21.9.	Materials
28.9.	Energy
5.10.	Space & time

Natural cycles (prof. Elisa Lähde)	
9.11.	Mastering
16.11.	Sustaining
23.11.	Regenerating

Summary	
30.11.	Presentation of portfolios + discussion
7.12.	Closing guest lecture

Course work: Portfolio

- **Make your summary of *Sustainable Design Principles***
- **Compose a portfolio that includes**
  - Letter to your MEP (resource cycles)
  - Flow chart (computational cycles)
  - Ecosystem service map (natural cycles)
- **Add reflections**
  - Reflection of visiting lectures
  - Additional reading
- **Identify questions**
  - What remained unanswered, untouched?
- **Carried out as group work**
  - Agree on the tasks in the group
  - Present your work
  - Return into MyCourses
- **Grading**
  - Based on individual assignments and reflections

Make groups!

- 6 persons per group
- Same group continues the whole autumn
- Mixed groups with different disciplines of architecture

Group 1 … 25

last name	first names	student ID	Arch/Land/Int
			Land
			Int

send your group info to toni.kotnik@aalto.fi by Tuesday 13 Sept, 17:00

after deadline all remaining students will be distributed!

Questions at this point?

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School of Arts, Design
and Architecture

Introduction to the course

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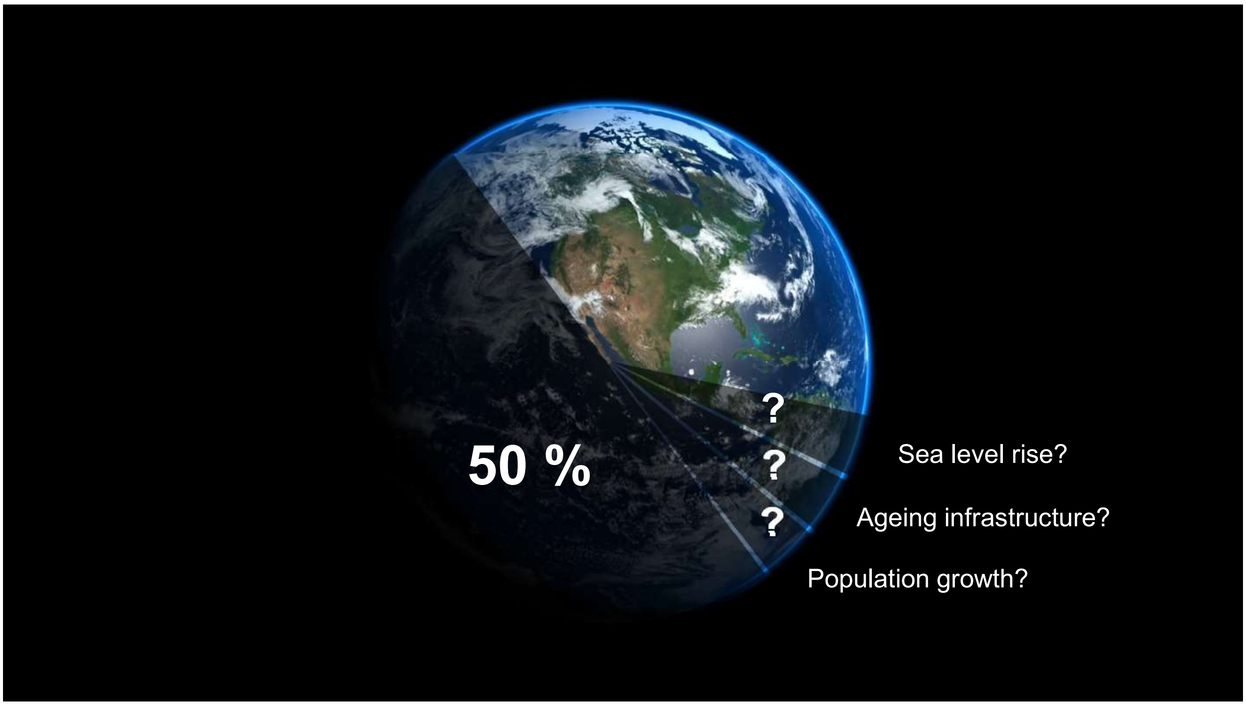
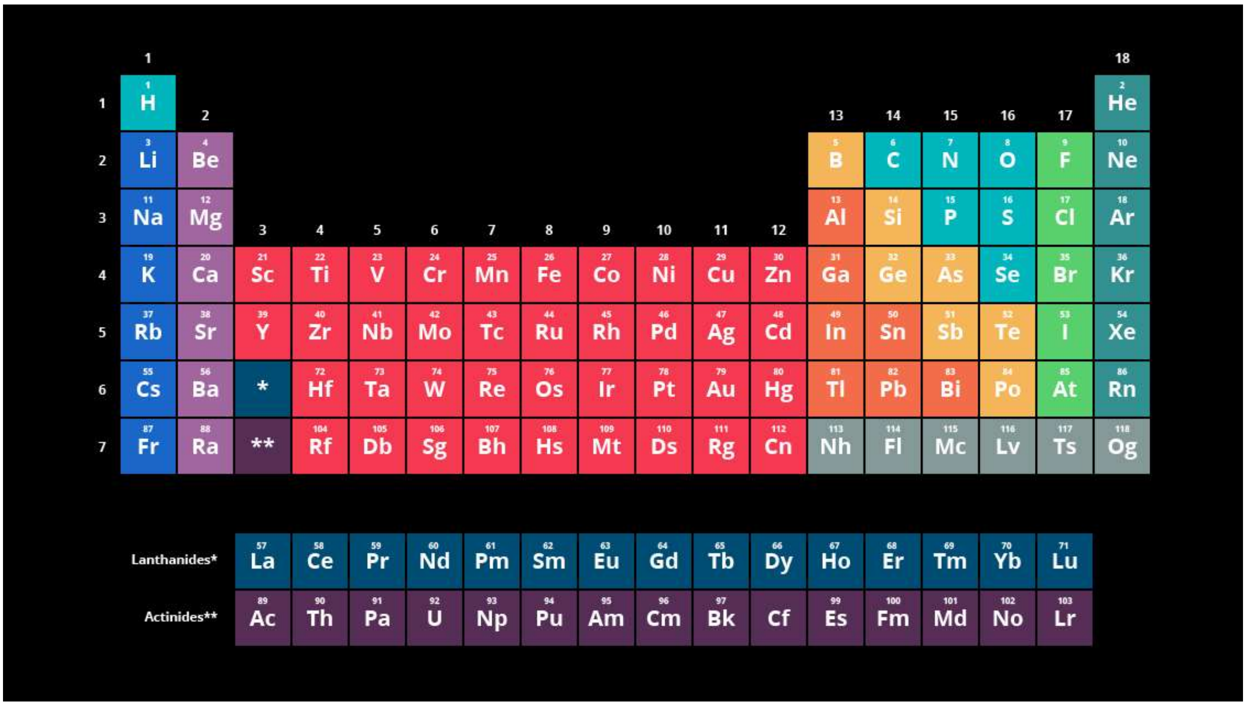
School of Arts, Design
and Architecture

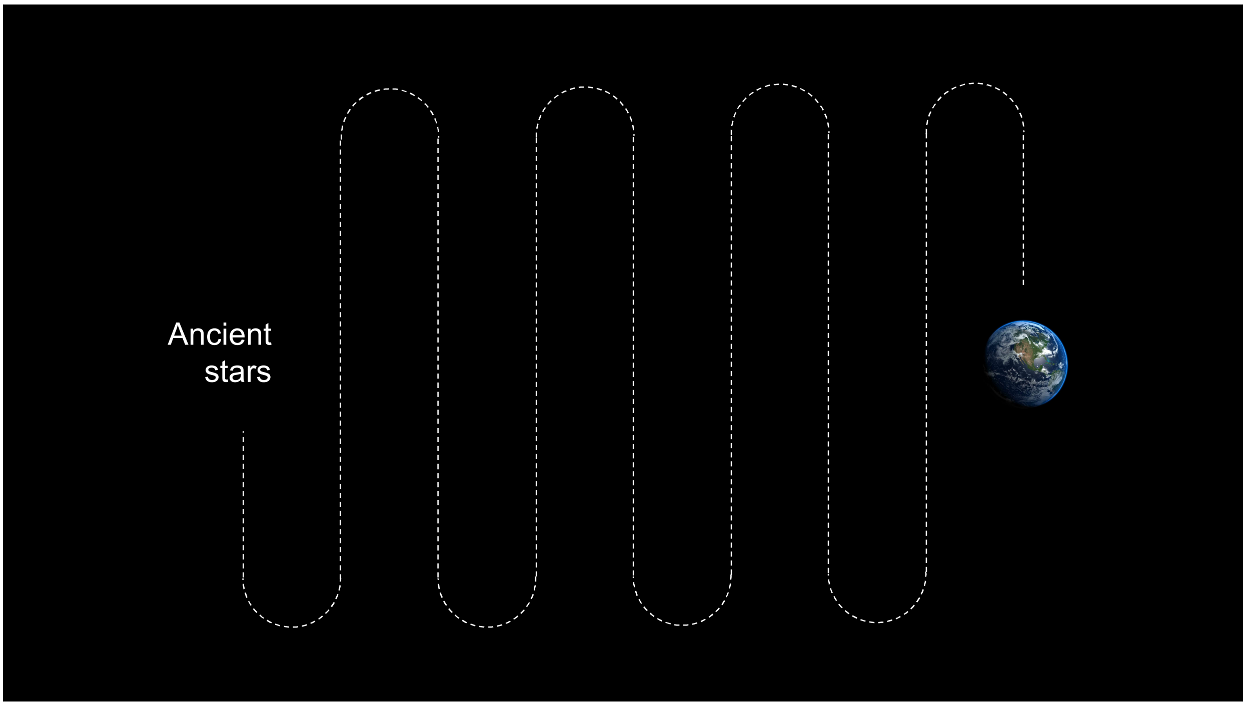
Resource cycles

Prof. Matti Kuittinen

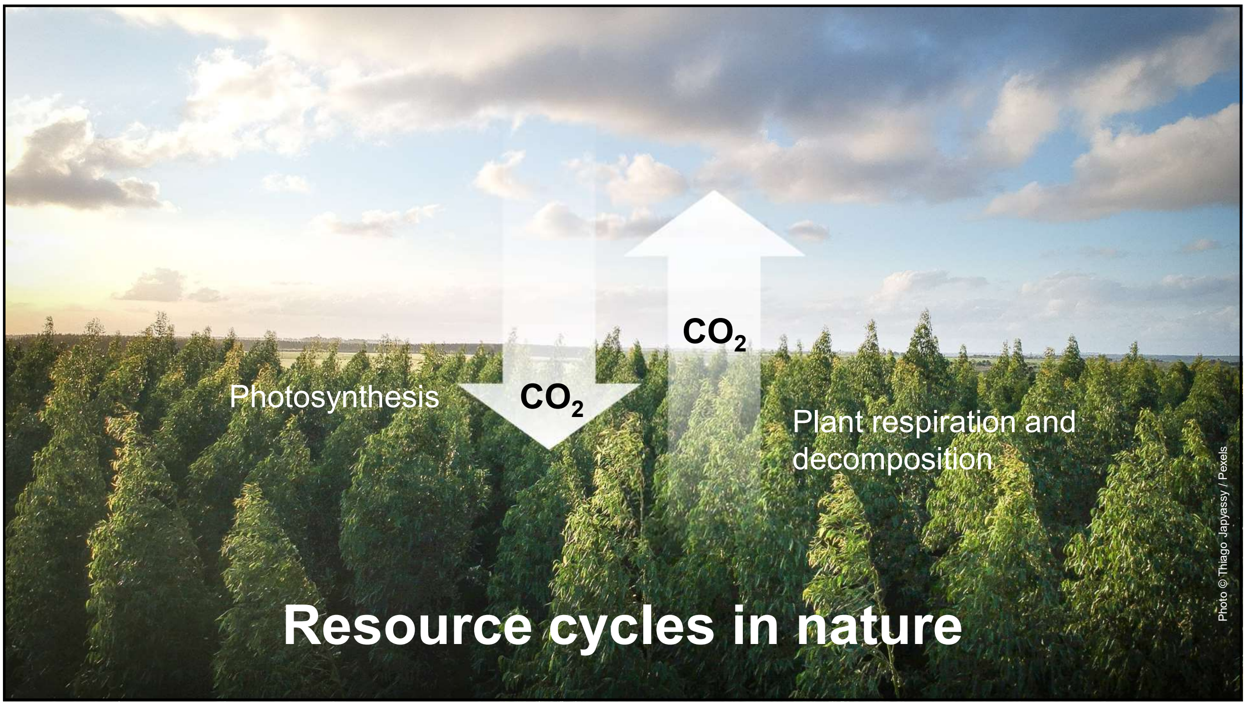



Timber
Copper
Gypsum
Rubber
Sand
Stone
Glass
Bronze
Plastics
Aluminium
PCBs
Steel
Lead
Cadmium
Asbestos
Photo: Pexels.com

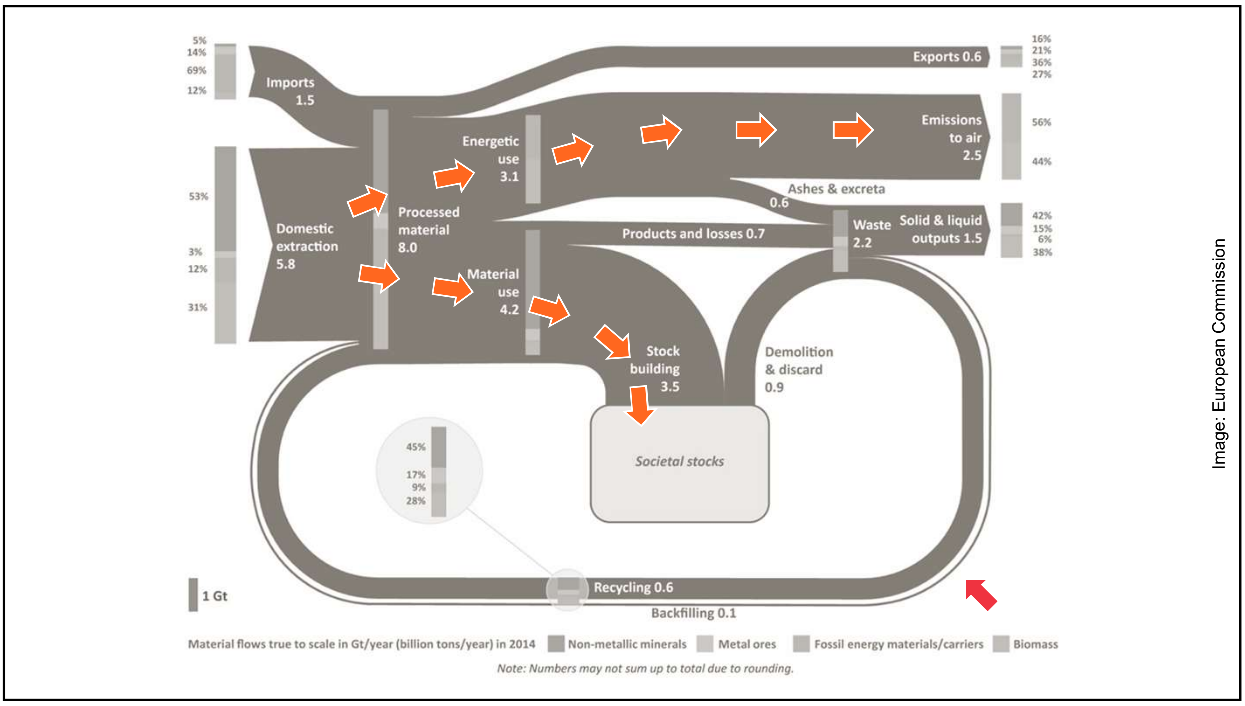

1 H He
2 Li Be B C N O F Ne
3 Na Mg Al Si P S Cl Ar
4 K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr
5 Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe
6 Cs Ba * Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn
7 Fr Ra ** Rf Db Sg Bh Hs Mt Ds Rg Cn Nh Fl Mc Lv Ts Og
Lanthanides* La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
Actinides** Ac Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr


Ancient
stars


Energy
Materials
Work
Capital
Space
Revenue
Waste
Emissions
Resource cycles in the built environment
Photo © Chris Schippers/Pexels



CO_2
Photosynthesis
CO_2
Plant respiration and decomposition
Photo © Thiago Japyassy / Pexels
Resource cycles in nature


Imports 1.5
Domestic extraction 5.8
Processed material 8.0
Energetic use 3.1
Material use 4.2
Exports 0.6
Emissions to air 2.5
Ashes & excreta 0.6
Products and losses 0.7
Waste 2.2
Solid & liquid outputs 1.5
Stock building 3.5
Demolition & discard 0.9
Societal stocks
Recycling 0.6
Backfilling 0.1
1 Gt
Material flows true to scale in Gt/year (billion tons/year) in 2014
Non-metallic minerals
Metal ores
Fossil energy materials/carriers
Biomass
Note: Numbers may not sum up to total due to rounding.
Image: European Commission

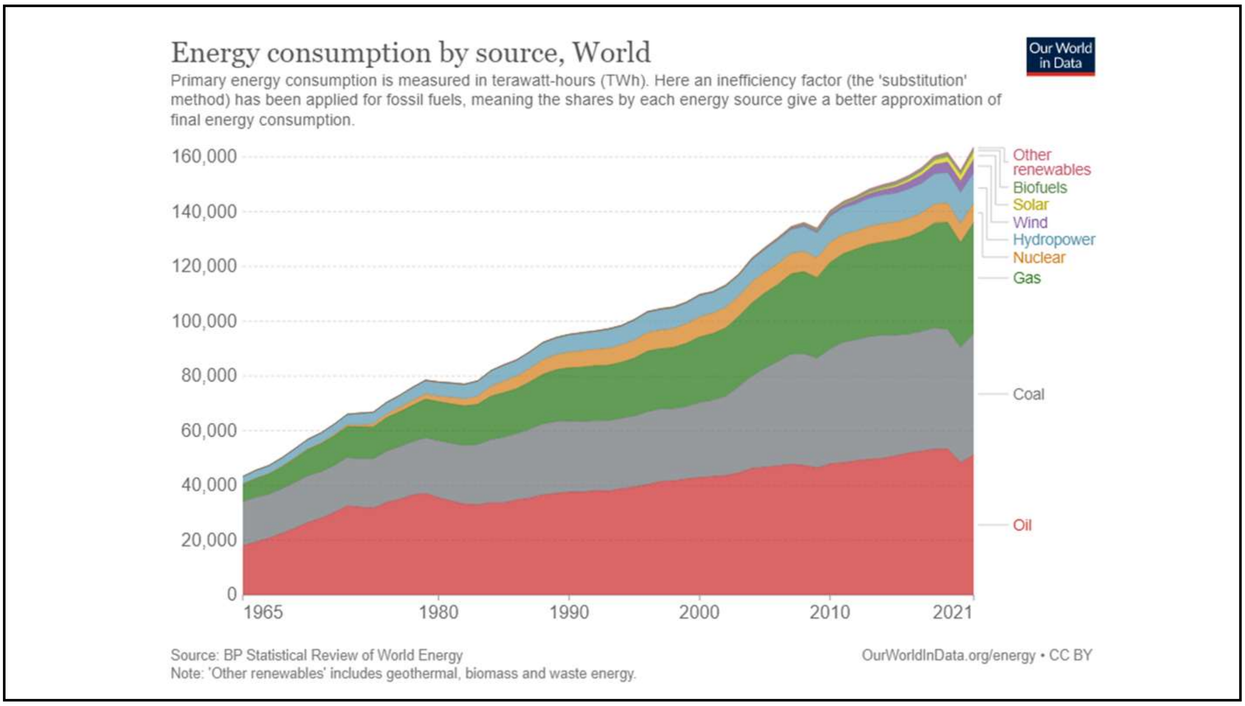
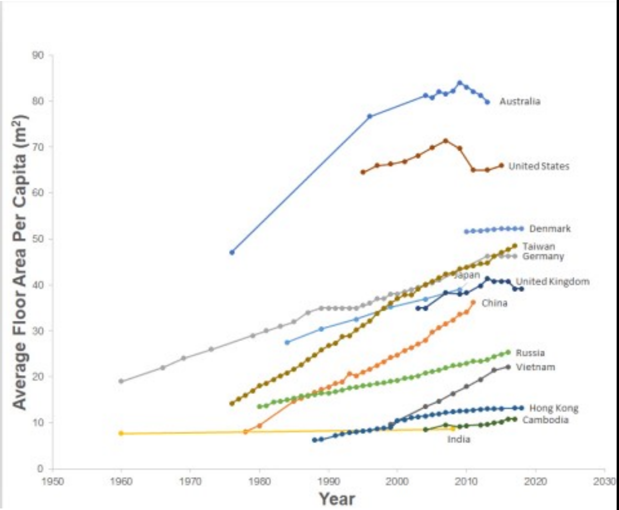

Energy consumption by source, World
Primary energy consumption is measured in terawatt-hours (TWh). Here an inefficiency factor (the 'substitution' method) has been applied for fossil fuels, meaning the shares by each energy source give a better approximation of final energy consumption.
Our World in Data
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1965
1980
1990
2000
2010
2021
Other renewables
Biofuels
Solar
Wind
Hydropower
Nuclear
Gas
Coal
Oil
Source: BP Statistical Review of World Energy
OurWorldInData.org/energy • CC BY
Note: 'Other renewables' includes geothermal, biomass and waste energy.

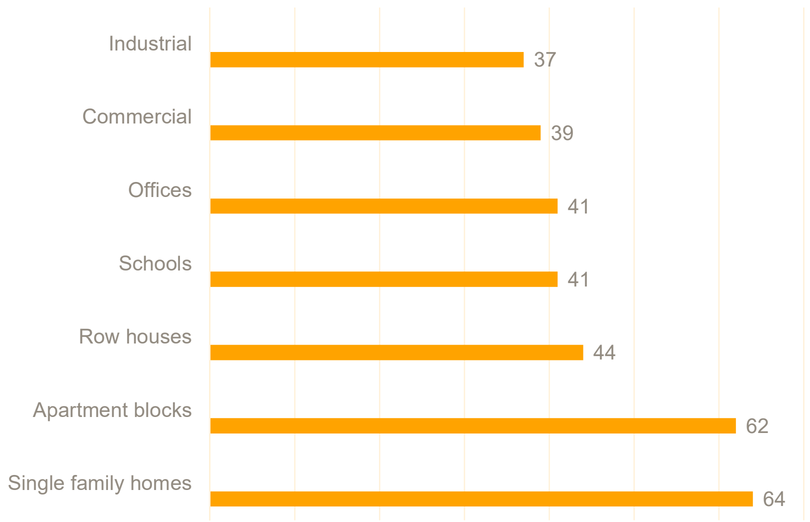

Photo: Jean van der Meulen / Pexels


Australia 80m²
US 65m²
Denmark 52m²
Germany 46m²
Taiwan 45m²
UK 41m²
China 37m²
Russia 24m²
Vietnam 18m²
Hong Kong 13m²
Cambodia 10m²
Floor Area Per Capita
Based on government data 2012/2013


Average Floor Area Per Capita (m²)
Year
Australia
United States
Denmark
Taiwan
Germany
Japan
United Kingdom
China
Russia
Vietnam
Hong Kong
Cambodia
India

Typical demolition ages of buildings in Finland

(Prof. Satu Huuhka, Tampere University)



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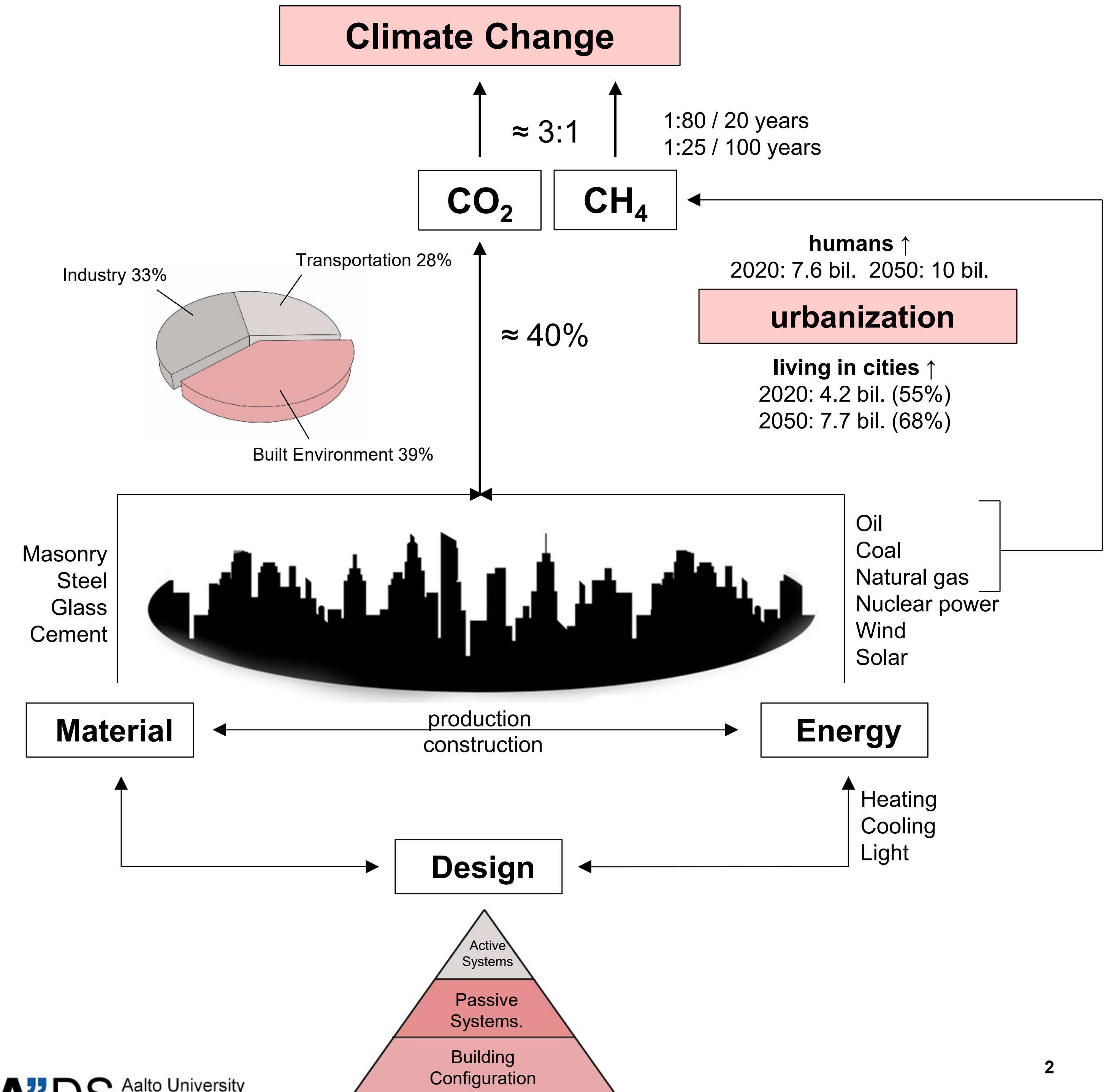
Computational cycles

Prof. Toni Kotnik


Climate Change
≈ 3:1
1:80 / 20 years
1:25 / 100 years
CO2
CH4
Industry 33%
Transportation 28%
Built Environment 39%
≈ 40%
humans ↑
2020: 7.6 bil. 2050: 10 bil.
urbanization
living in cities ↑
2020: 4.2 bil. (55%)
2050: 7.7 bil. (68%)
Masonry
Steel
Glass
Cement
Oil
Coal
Natural gas
Nuclear power
Wind
Solar
Material
production
construction
Energy
Heating
Cooling
Light
Design
Active Systems
Passive Systems.
Building Configuration

Helsinki Metropolitan Area

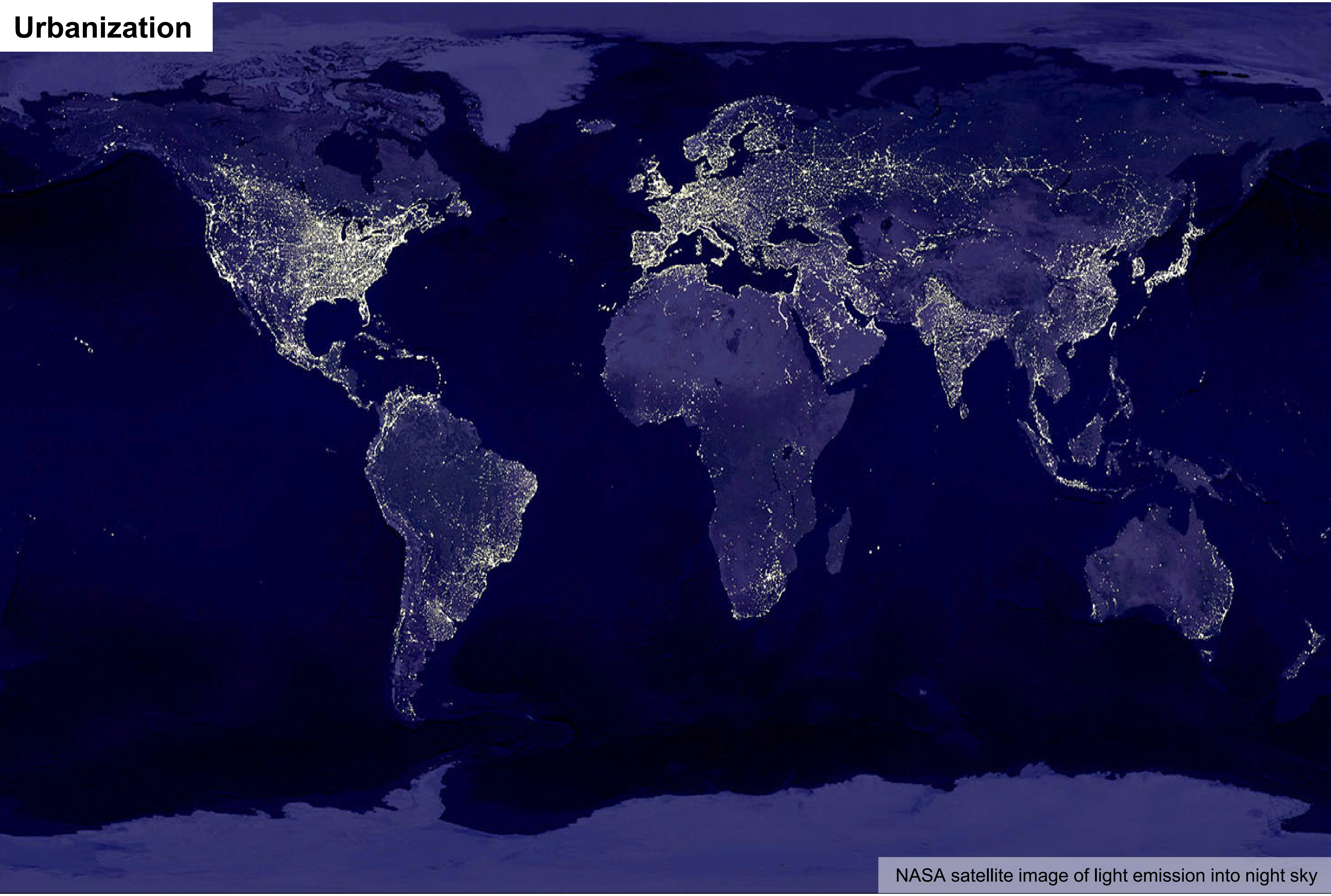
population (city)
2020: 635´000
2050: 840´000
+ 32%

population (total)
2020: 1.3 mil.
2050: 2.0 mil.
+ 53%

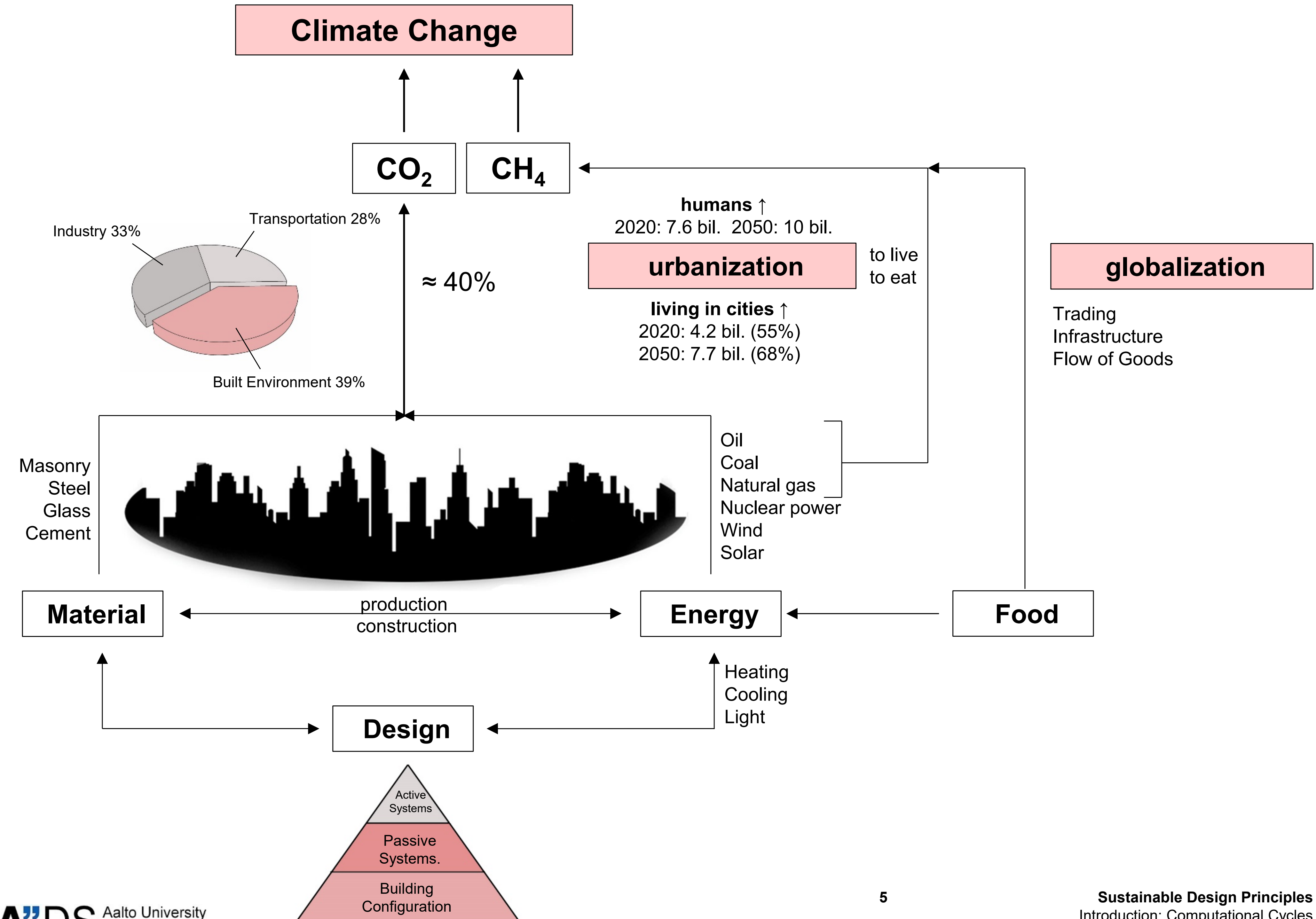
population in 2050
- 450´000 native speaker
+ 490´000 foreign language

Helsinki will grow and transform into an international hub

Urbanization



NASA satellite image of light emission into night sky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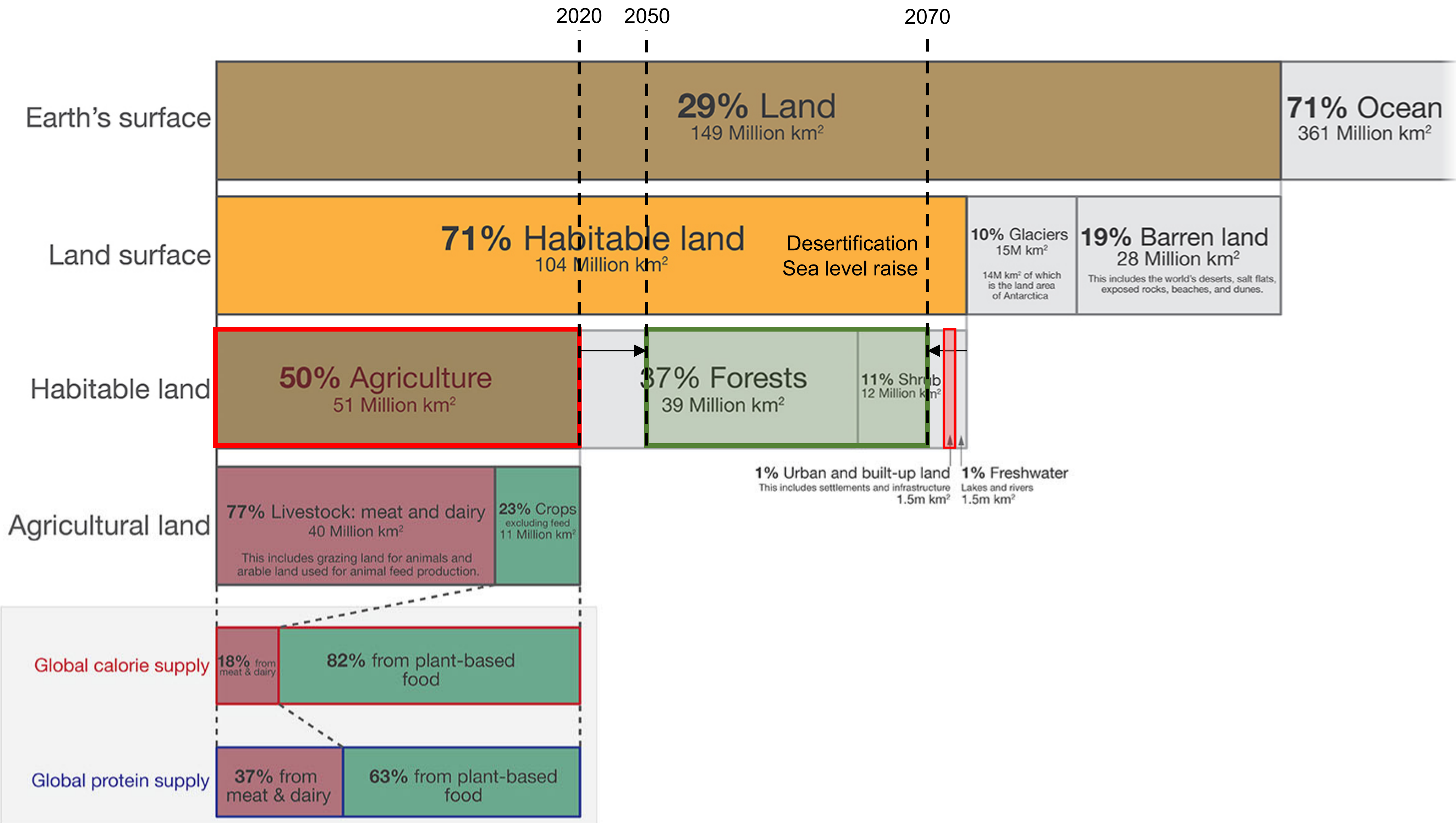
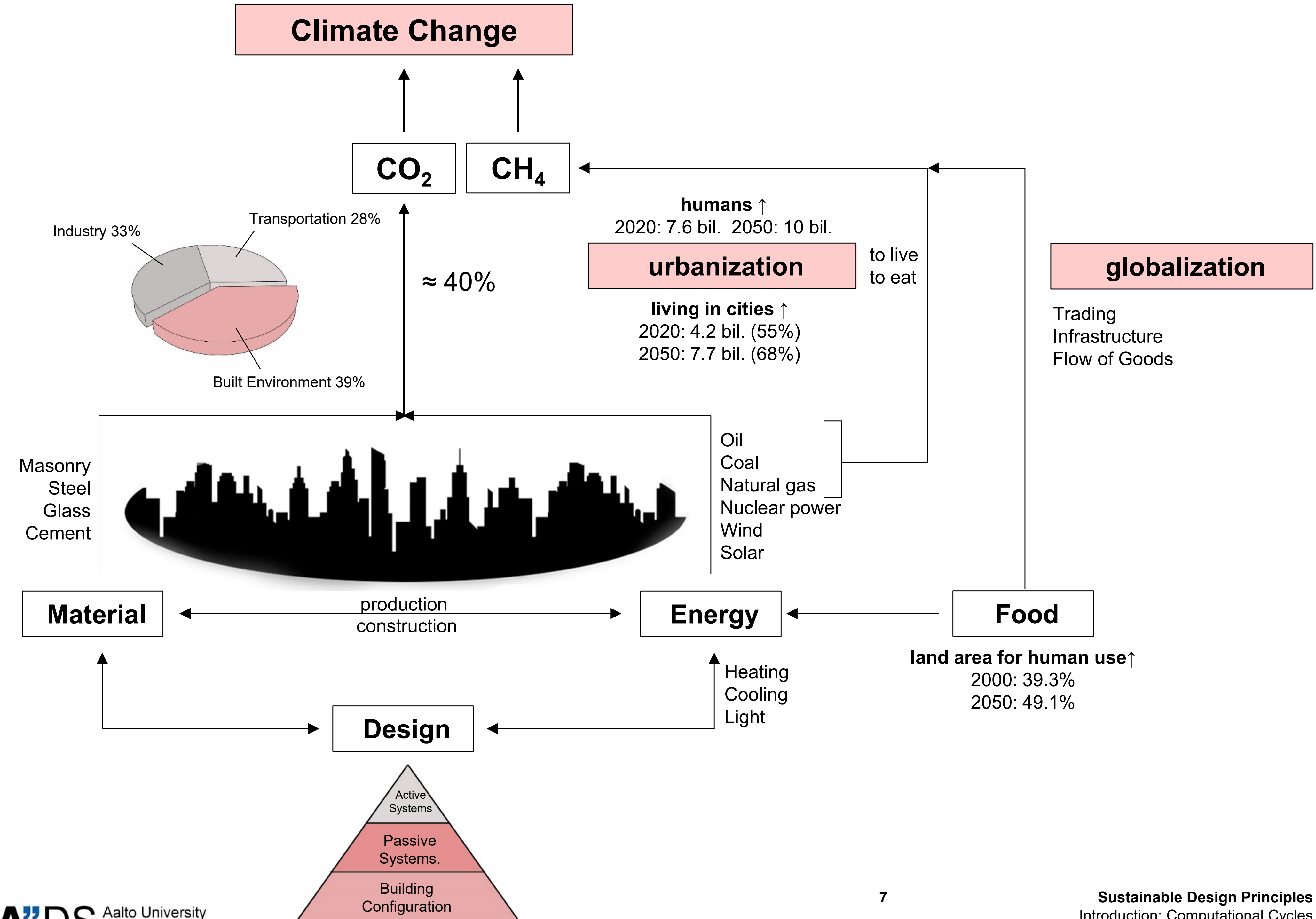
Global land use for food production



UN Food and Agriculture Organization (FAO), 2019



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land area for human use↑
2000: 39.3%
2050: 49.1%
Heating
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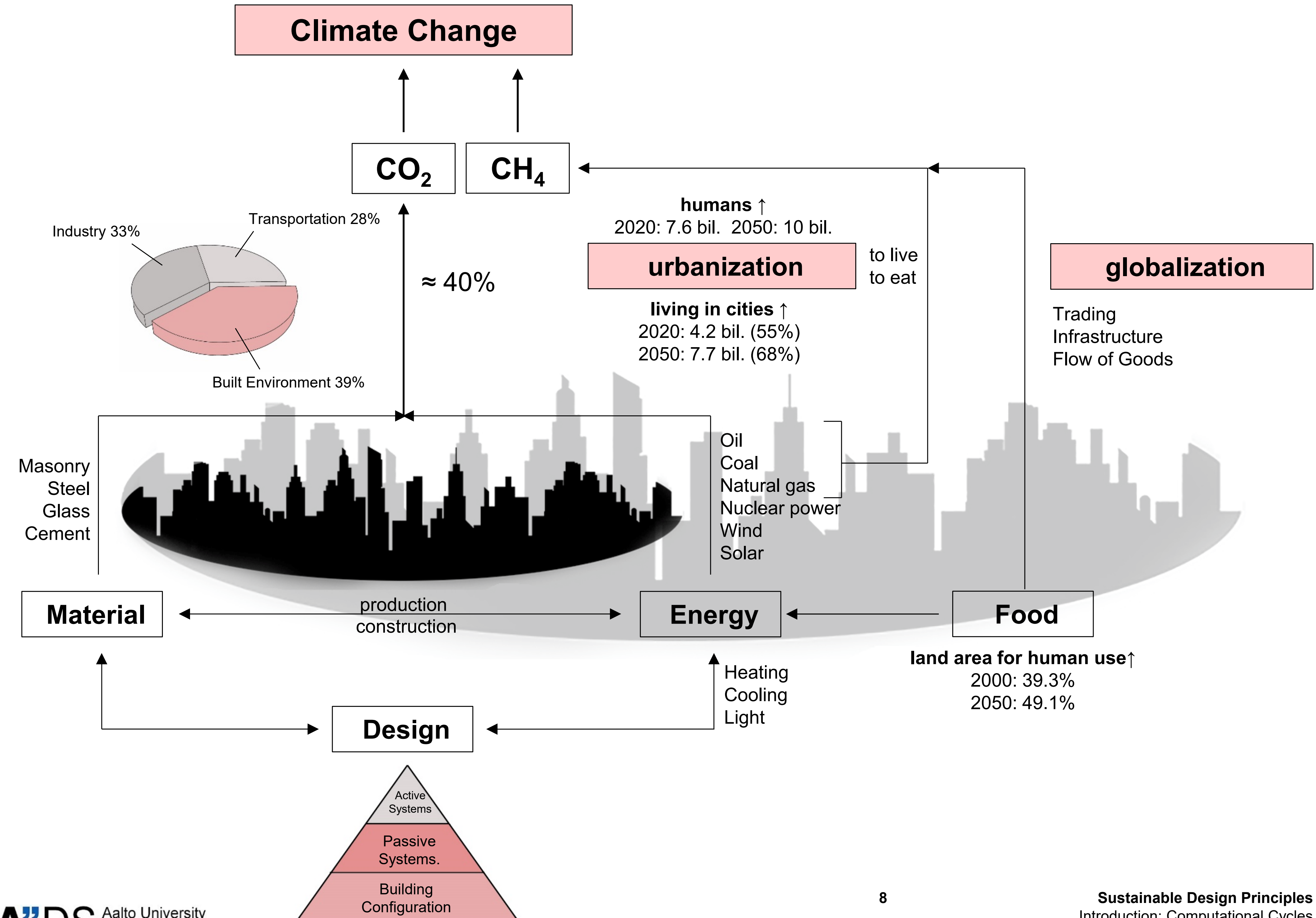
Building Configuration



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Habitat Loss

Habitat Loss

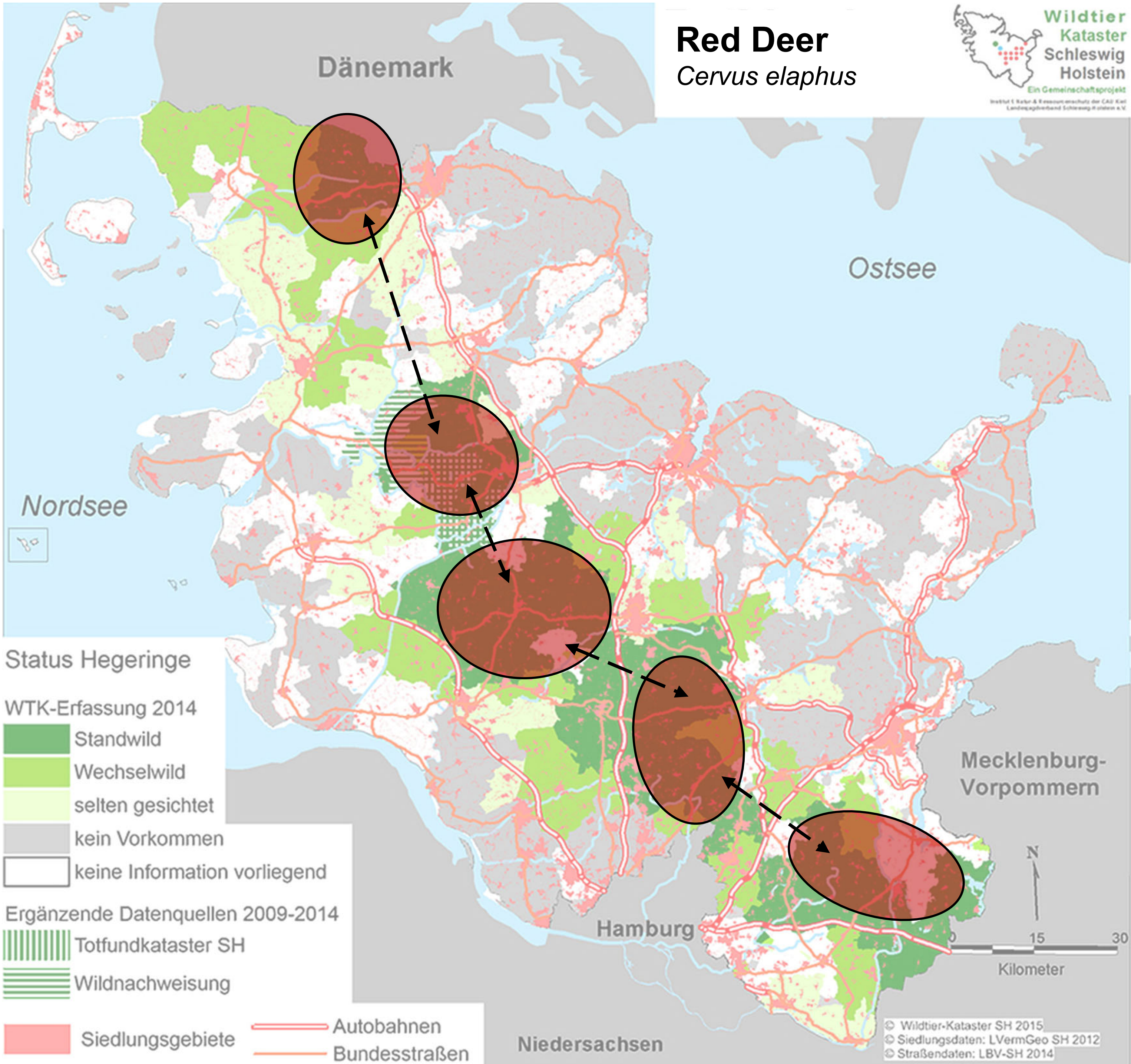
restricted movement

limited exchange

limited genetic variability

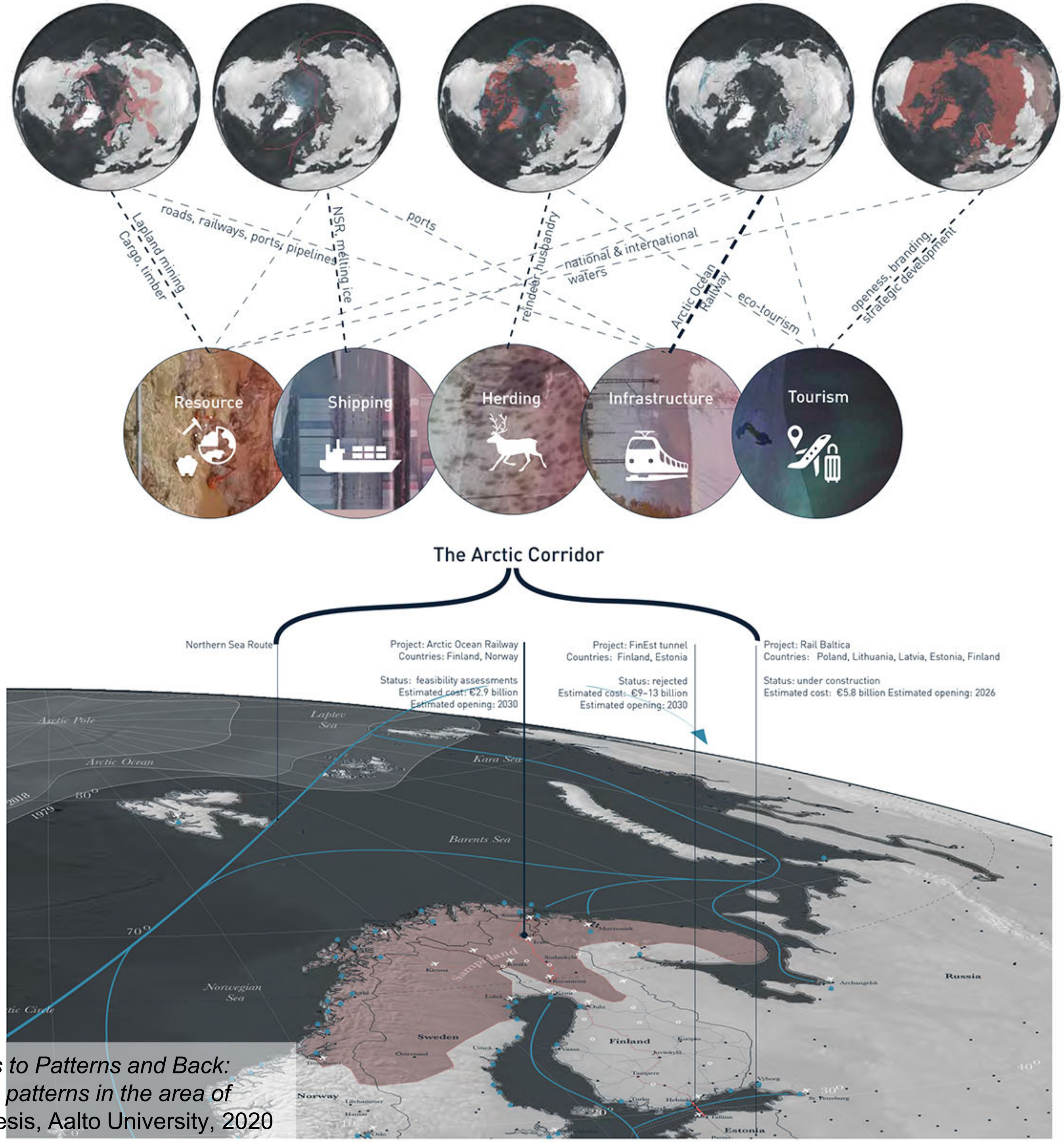
increased number of birth defects

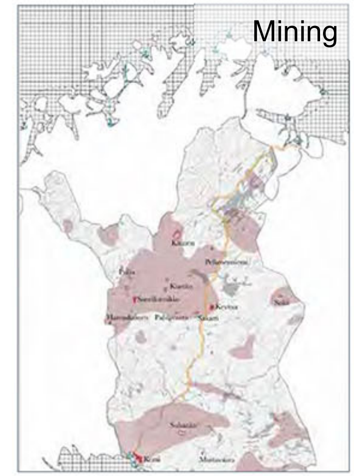
reduced chance of survival

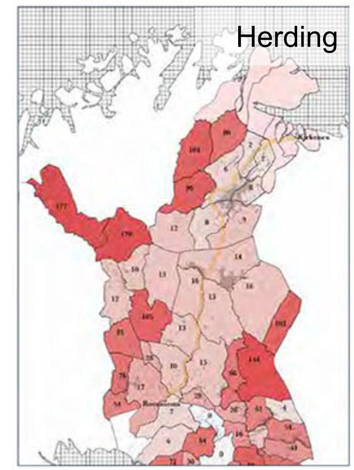


Habitat Loss

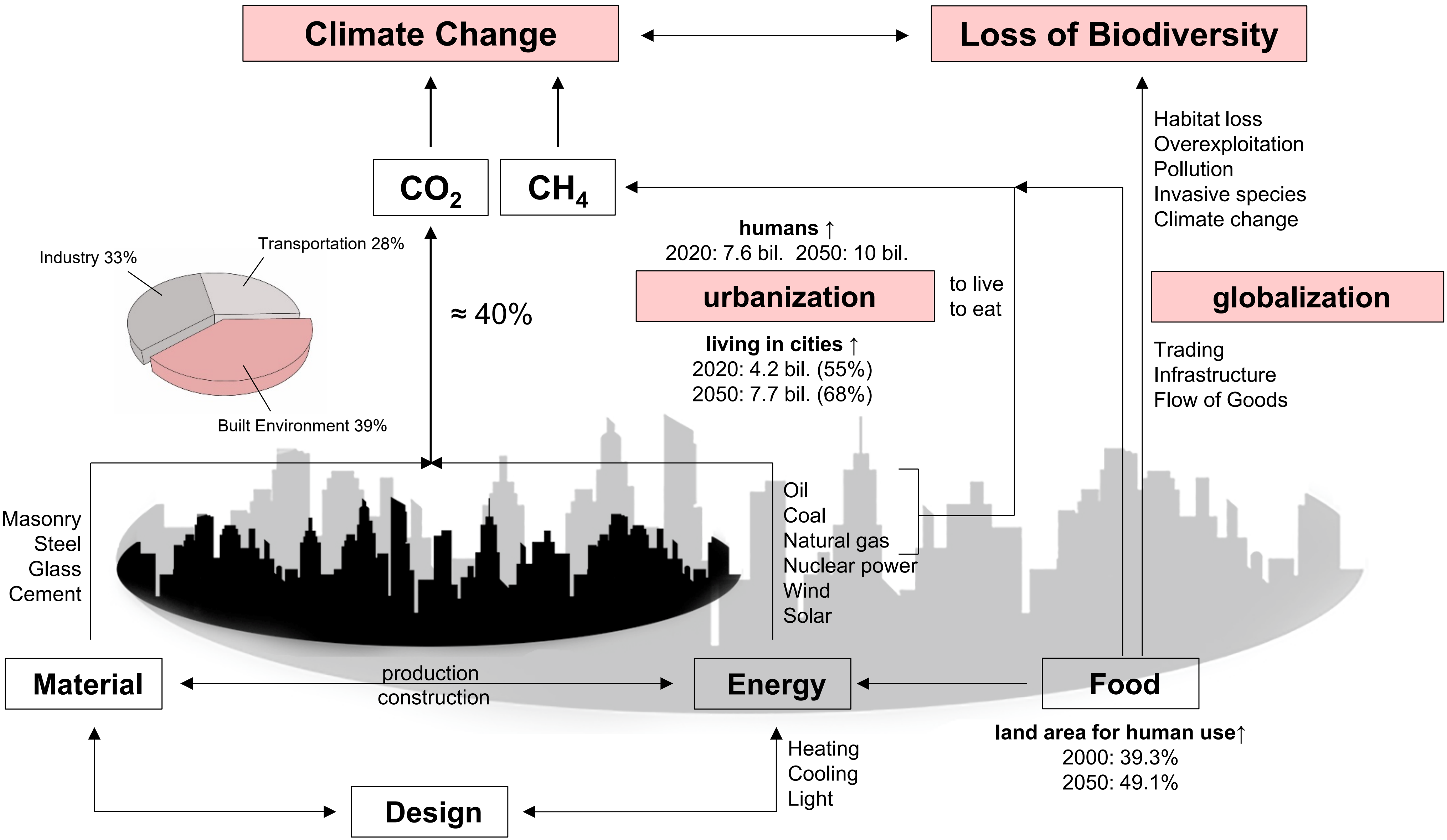
Habitat Loss







Ayda Grisiute: *From Systems to Patterns and Back: Exploring the role of dynamic patterns in the area of regional planning,* Master Thesis, Aalto University, 2020



Climate Change
Loss of Biodiversity
CO2
CH4
Habitat loss
Overexploitation
Pollution
Invasive species
Climate change
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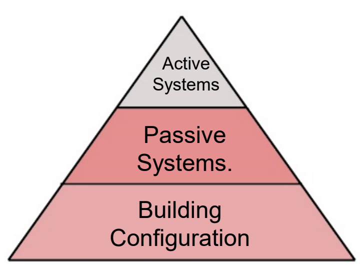
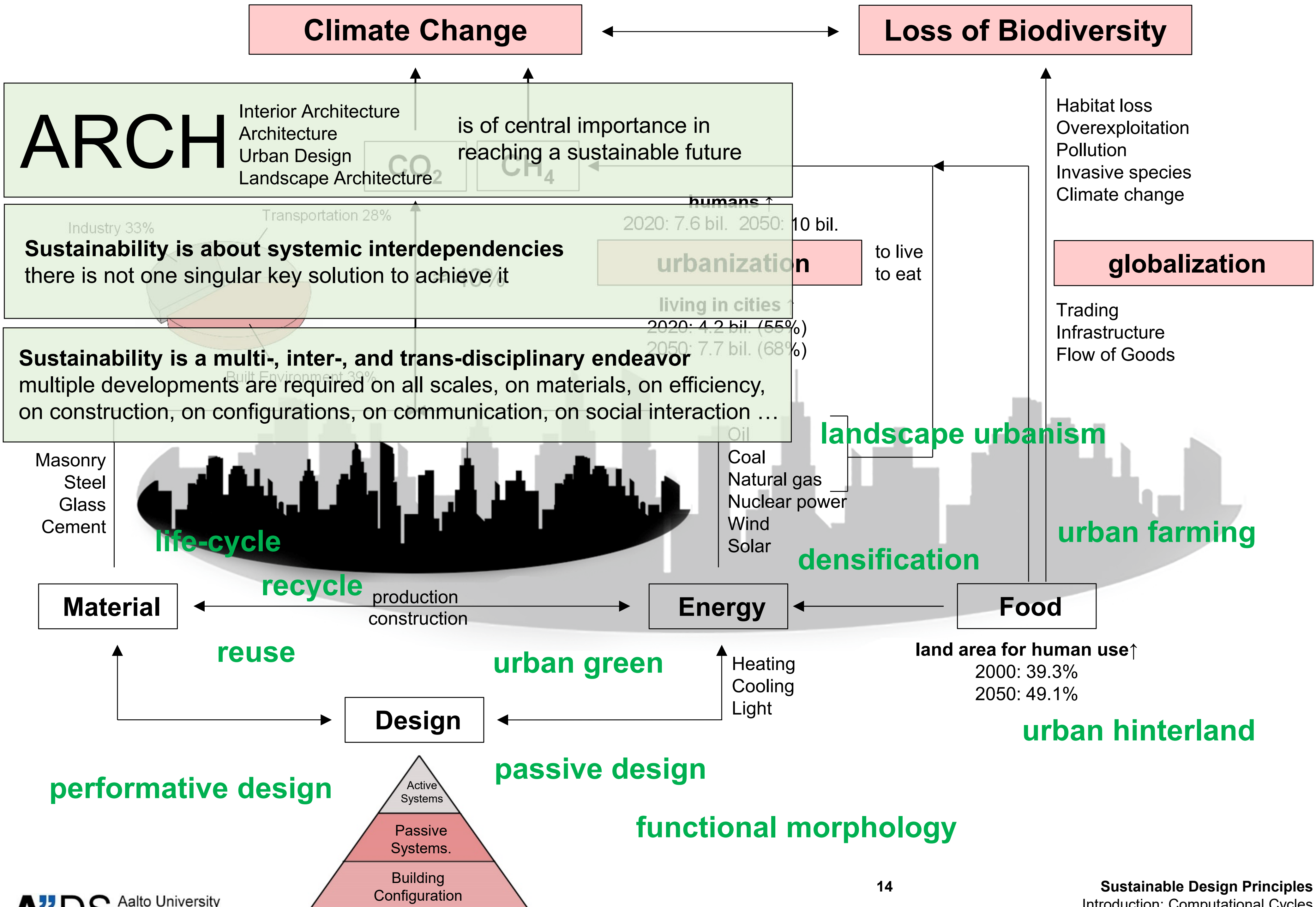
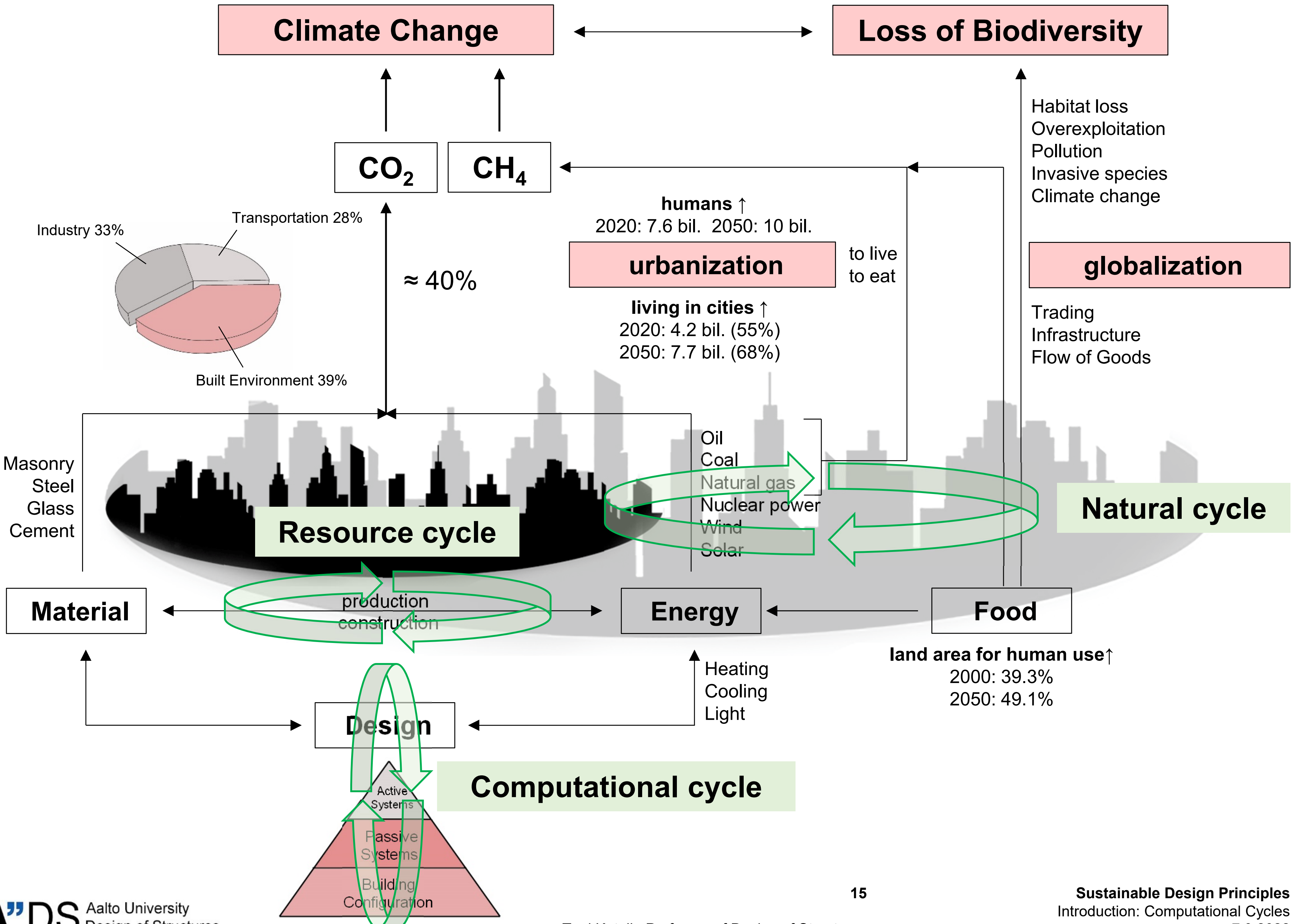


Active
Systems
Passive
Systems.
Building
Configuration



A'' DS Aalto University
Design of Structures
Toni Kotnik, Professor of Design of Structures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Computational cycle
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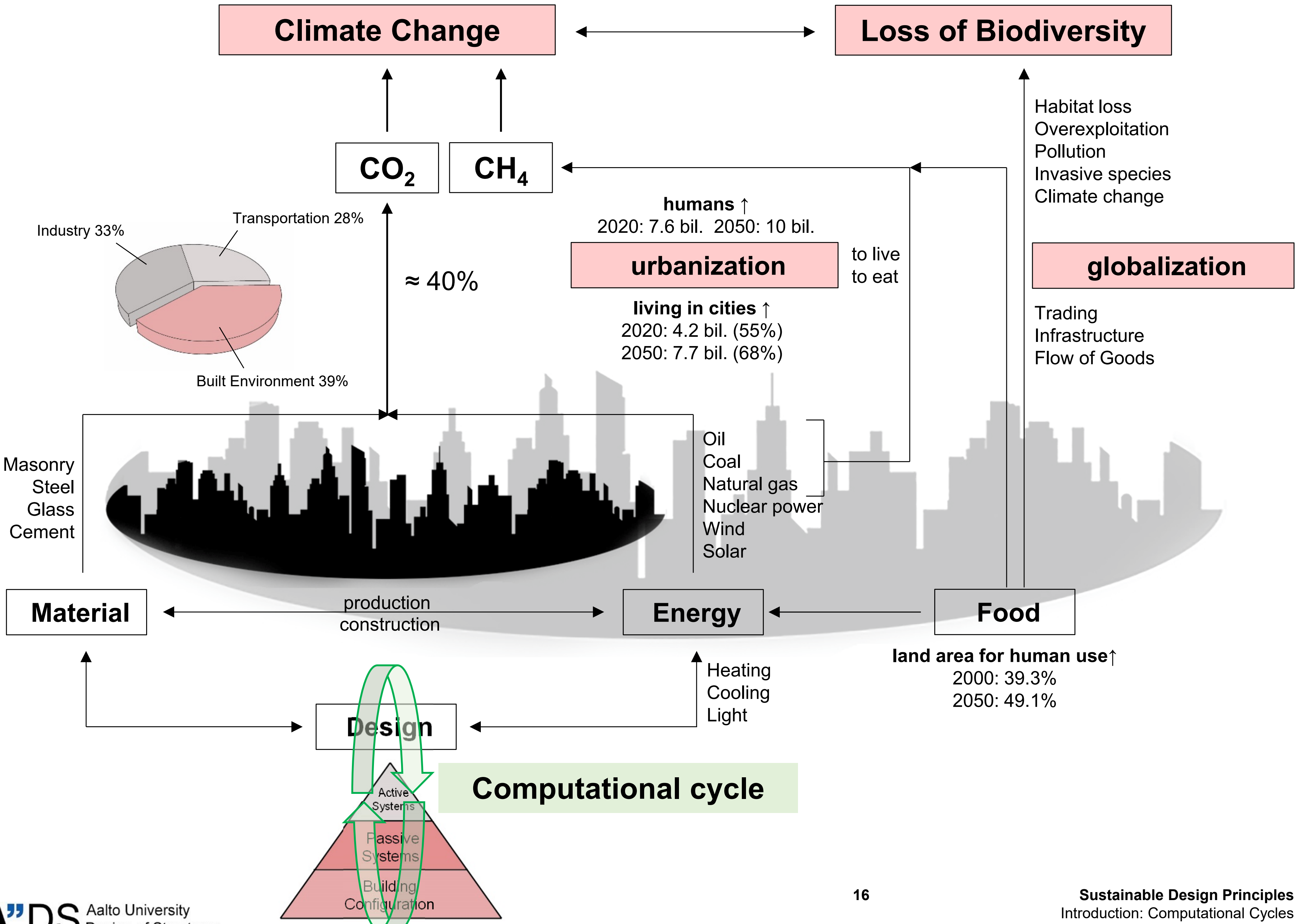
Passive Systems
Building Configuration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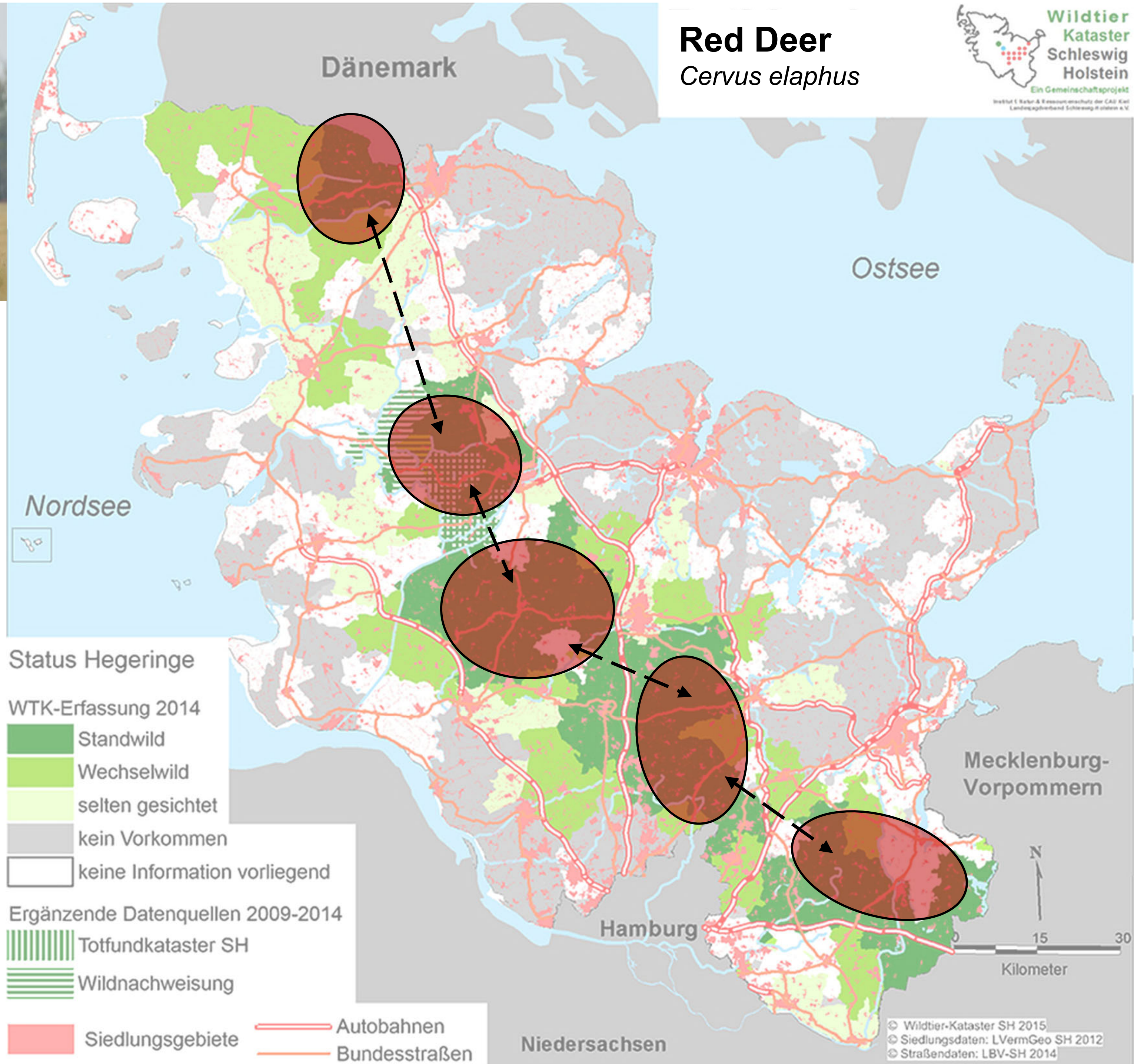
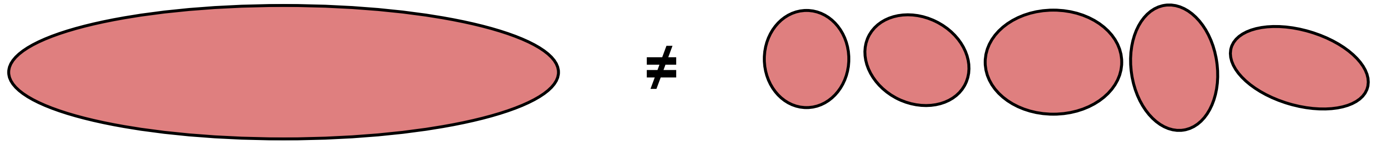
Red Deer

Cervus elaphus



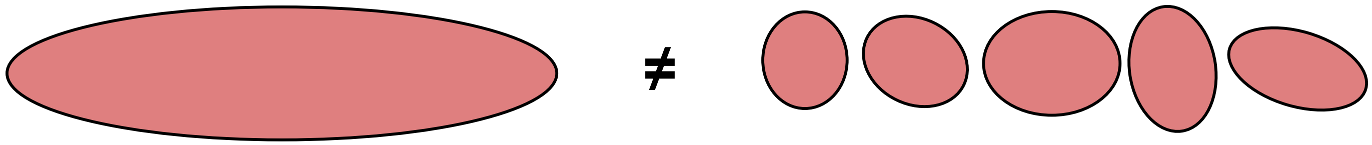


formed material

hyle matter ⇄ form *eidos*

materialized form

form has an impact on functionality



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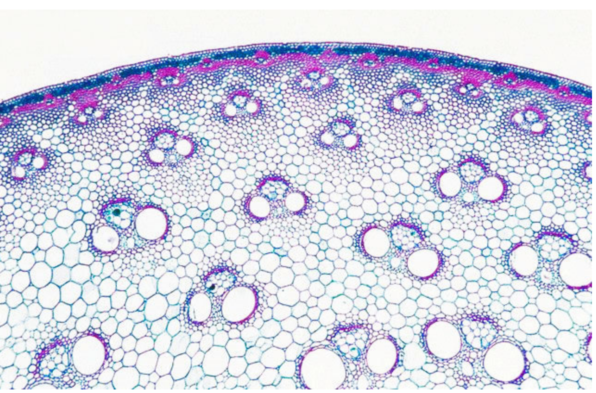
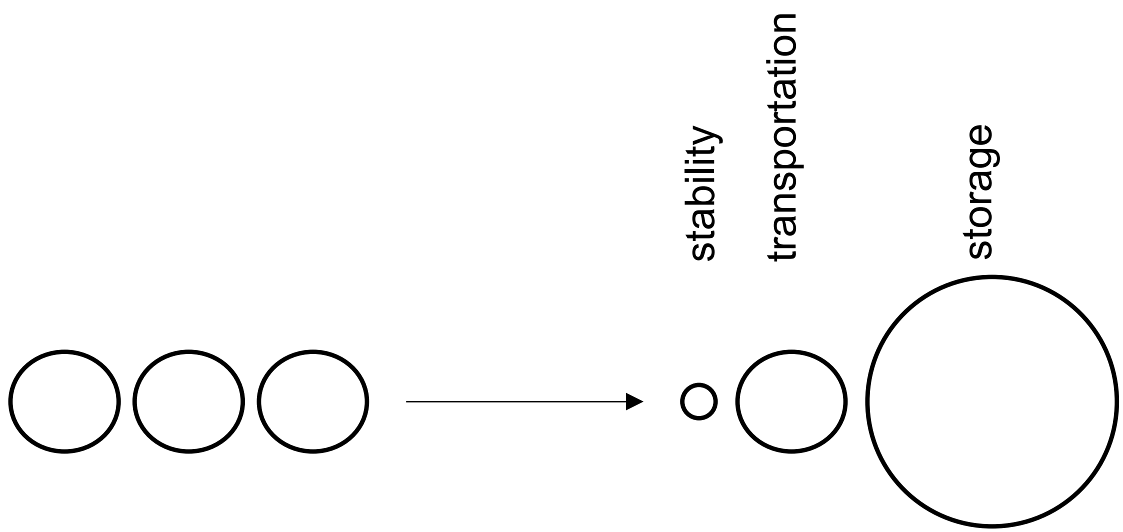
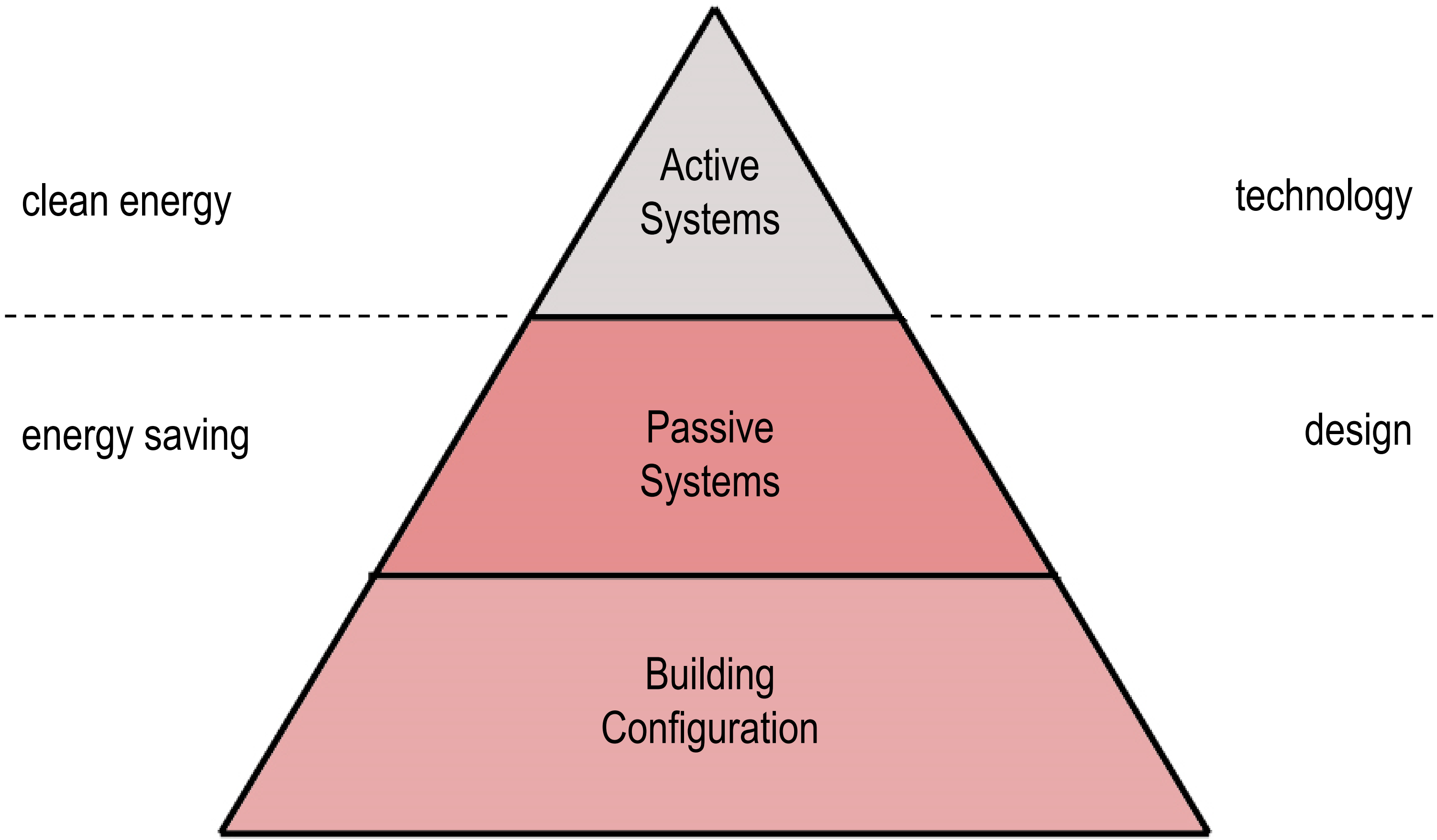
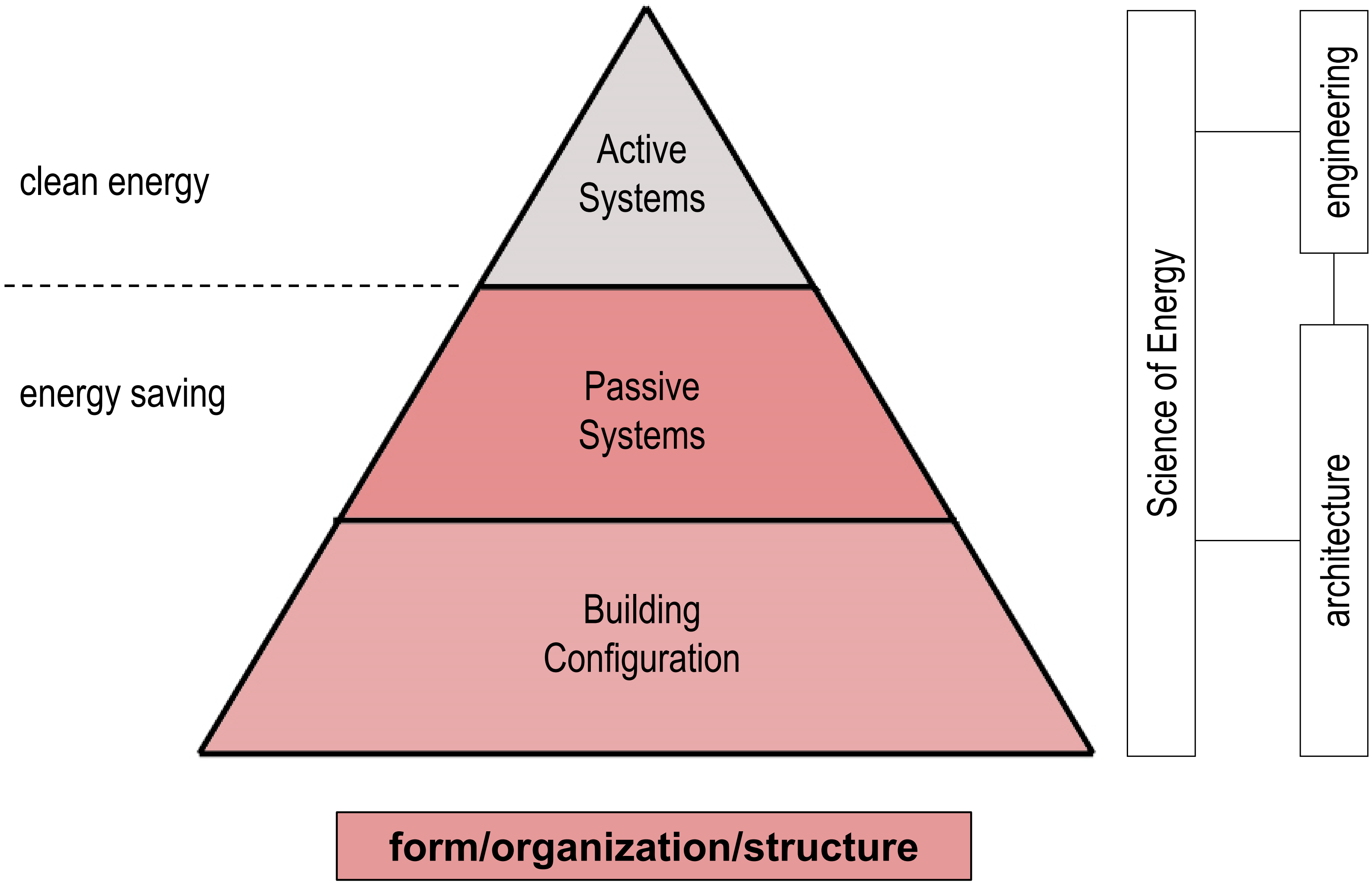






Stefan Behling
strategies towards a sustainable built environment
lecture, IIT Chicago, 2004



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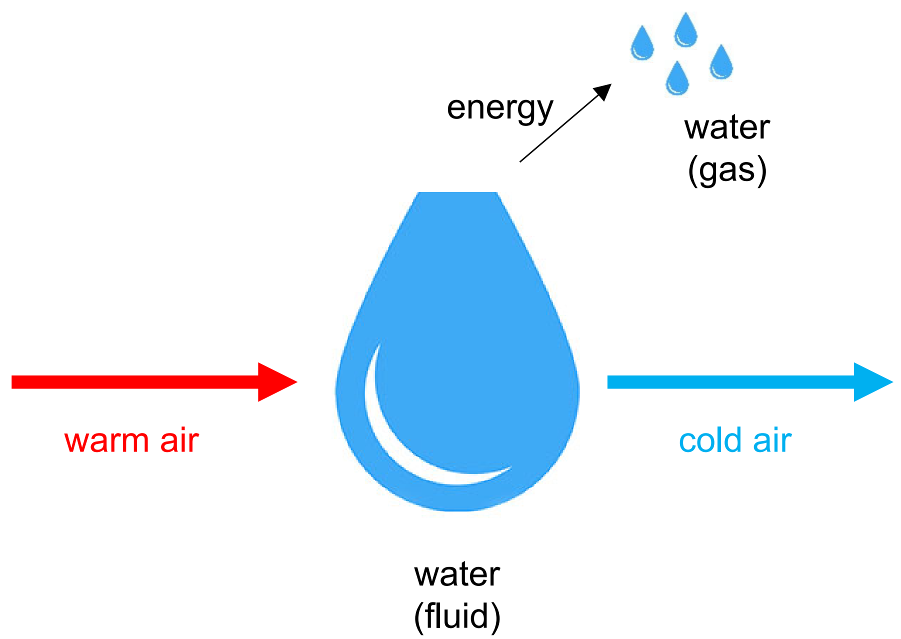
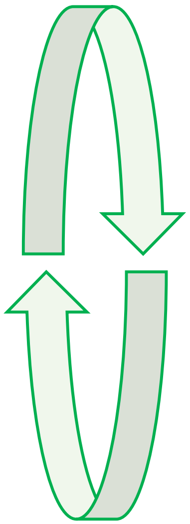
evaporative/adiabatic cooling



evaporative cooling as principle for wind towers
in traditional Iranian architecture

Palacio de Comares, Alhambra, Granada, Spain

Computational cycle | **form/organization/structure**



12.10 **Performative Form**: Passive design strategies — single-objective

save material / cooling / heating / …

26.10 **Found Form:** Natural computing — multi-objective

bottom-up / emergence / …

2.11 **Designed Form:** Architecture as extended nature — systemic

networks / complexity / generative / …

computational design thinking is of central importance for a sustainable future

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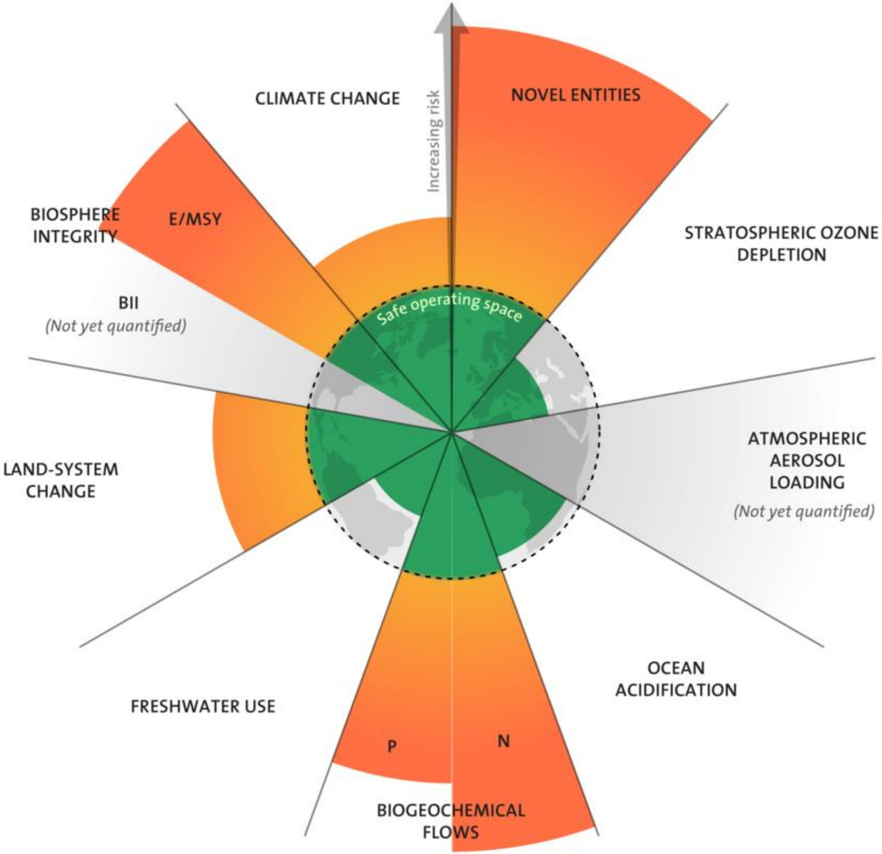
Natural cycles

Prof. Elisa Lähde

2015

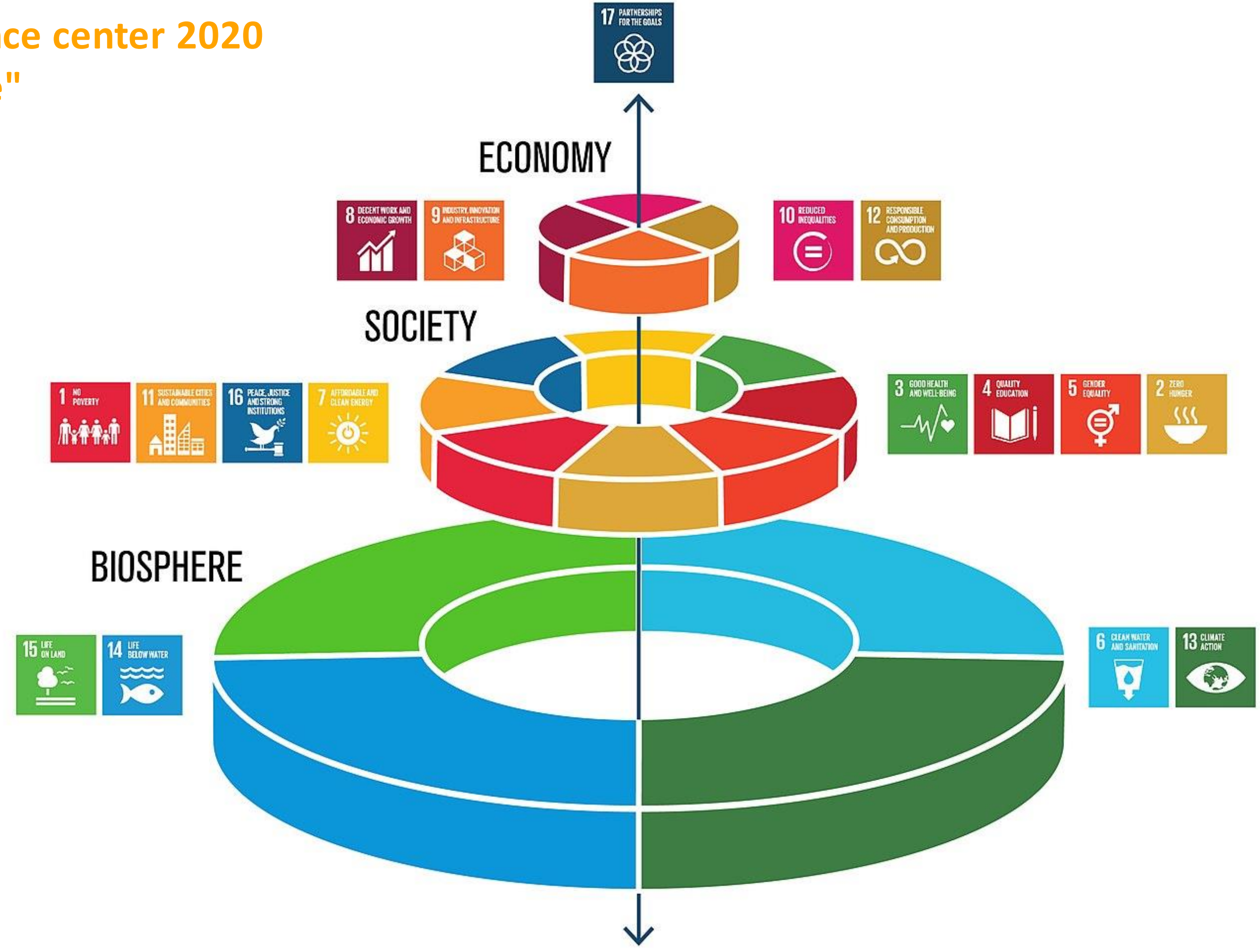

SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

The planetary boundaries
(The earth system group)



Anthropocene

Stockholm Resilience center 2020
"The wedding cake"



Graphics by Jerker Lokrantz/Azote

Systemic understanding

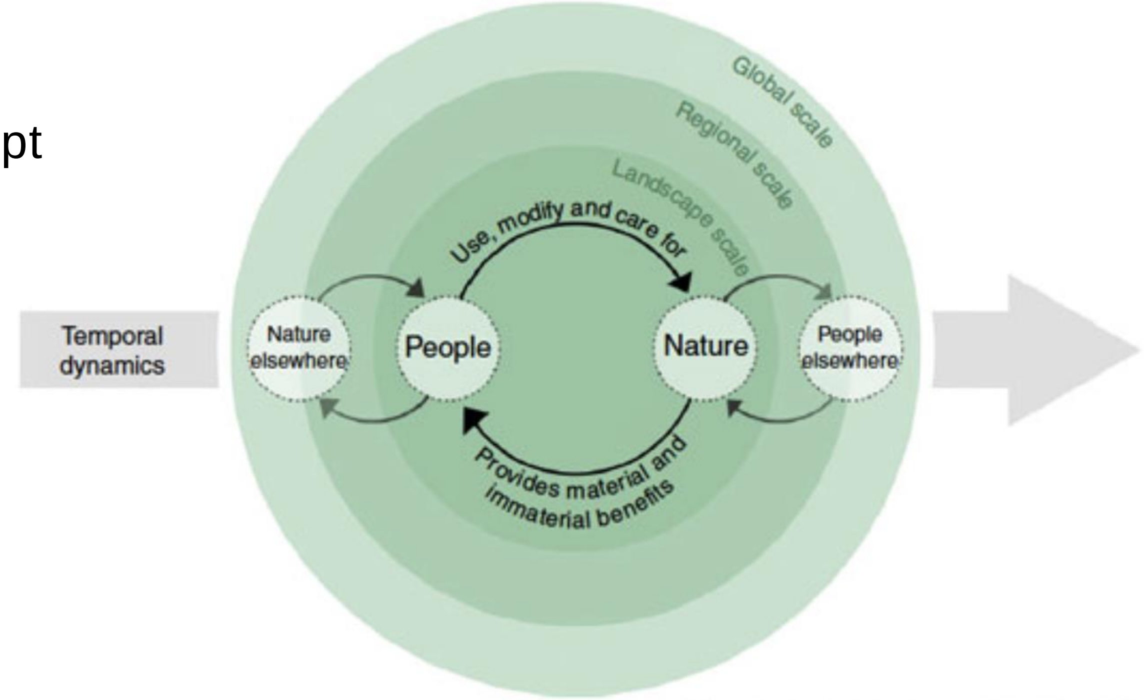
The pressing **environmental and social sustainability challenges** we face in the 21st century are **clearly deeply intertwined**.

These challenges result from the confluence and interaction of multiple, mutually reinforcing social and ecological processes at multiple scales (Folke et al. 2016), where social processes include economic, political, cultural and technological processes, and ecological processes include biotic (e.g. population dynamics, food web interactions) and abiotic (e.g. nutrient flows, climate patterns) processes.

Folke, C., R. Biggs, A.V. Norström, B. Reyers, and J. Rockström. 2016. 'Social-ecological Resilience and Biosphere-based Sustainability Science.' Ecology and Society 21(3): 41.

Social-ecological systems

‘Social-ecological systems’ (SES) is an emerging concept for understanding the intertwined nature of human and natural systems in interconnected and interdependent way.



Examples of social-ecological systems

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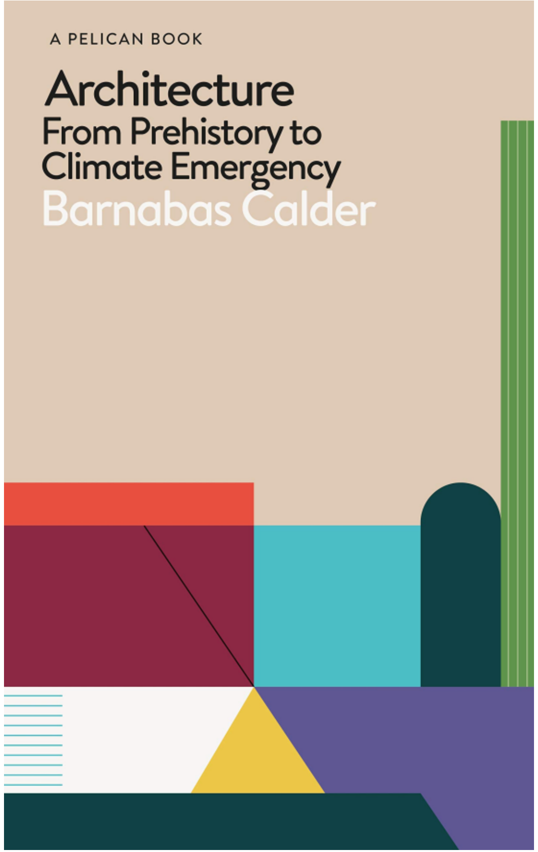
Next up

Prof. Elisa Lähde



Guest lecture next week

Dr. Barnabas Calder

University of Liverpool

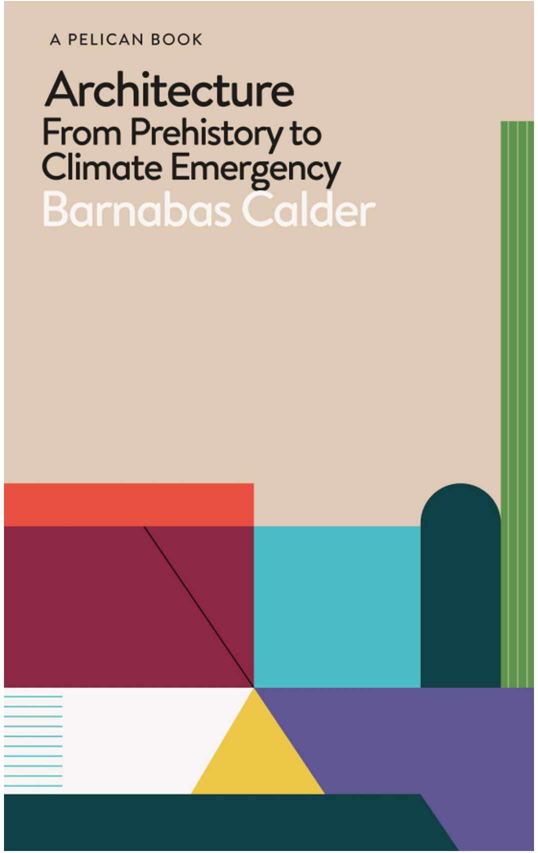
Required Reading

Barnabas Calder & G. A. Bremner: *Buildings and energy: architectural history in the climate emergency*, The Journal of Architecture, 2021, Vol 26, No 2, 79-115

In this text architecture is understood as a material phenomenon shaped by the constraints of the energy economy. How has the availability of energy shaped architecture and what does this imply for our understanding of sustainability? Read the text and prepare yourself for a question to Barnabas Calder.

Additional reading

Luis Fernández-Galiano: *Fire and Memory: On architecture and energy*, MIT Press, 2000, 2-32



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Wrap up & questions