Critical Perspectives on Sustainable Design

MAS.S73

I. What is sustainability? What is design?

1.10.2023

MIT acknowledges Indigenous Peoples as the traditional stewards of the land, and the enduring relationship that exists between them and their traditional territories.

The land on which we sit is the traditional **unceded territory** of the Wampanoag Nation.

We acknowledge the painful history of genocide and forced occupation of their territory, and we honor and respect the many diverse indigenous people connected to this land on which we gather from time immemorial.

What would this place look like if we had come to learn instead of colonize?

What is sustainability?

What is design?

1:00 - 2:00	Course Overview	**What is this? Who am I? Who are you?**
2:00 - 2:15	**Break**	
2:15 - 3:00	Lecture 1	What is sustainability? What is design?
3:00 - 3:15	**Break**	
3:00 - 4:00	Discussion	Is Nic’s work sustainable?
4:00 - 5:00	Studio	

Who are you?

What is sustainability?

What is design?

By the end of this unit, students will be able to:

1. *Summarize* current research and academic consensus on the nature of environmental, social, and economic sustainability.

2. *Critically evaluate* current approaches to the assessment of system sustainability such as LEED, LCA, or Emergy evaluation.

3. *Propose* appropriate justifications and metrics for assessing the sustainability of a given system.

What is sustainability?

What is design?

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What is

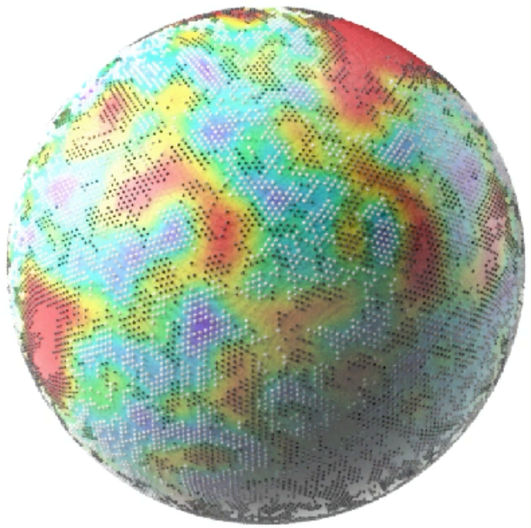
sustainability /

design /

this class /

me /

you /



Surface Temperature
(C°)

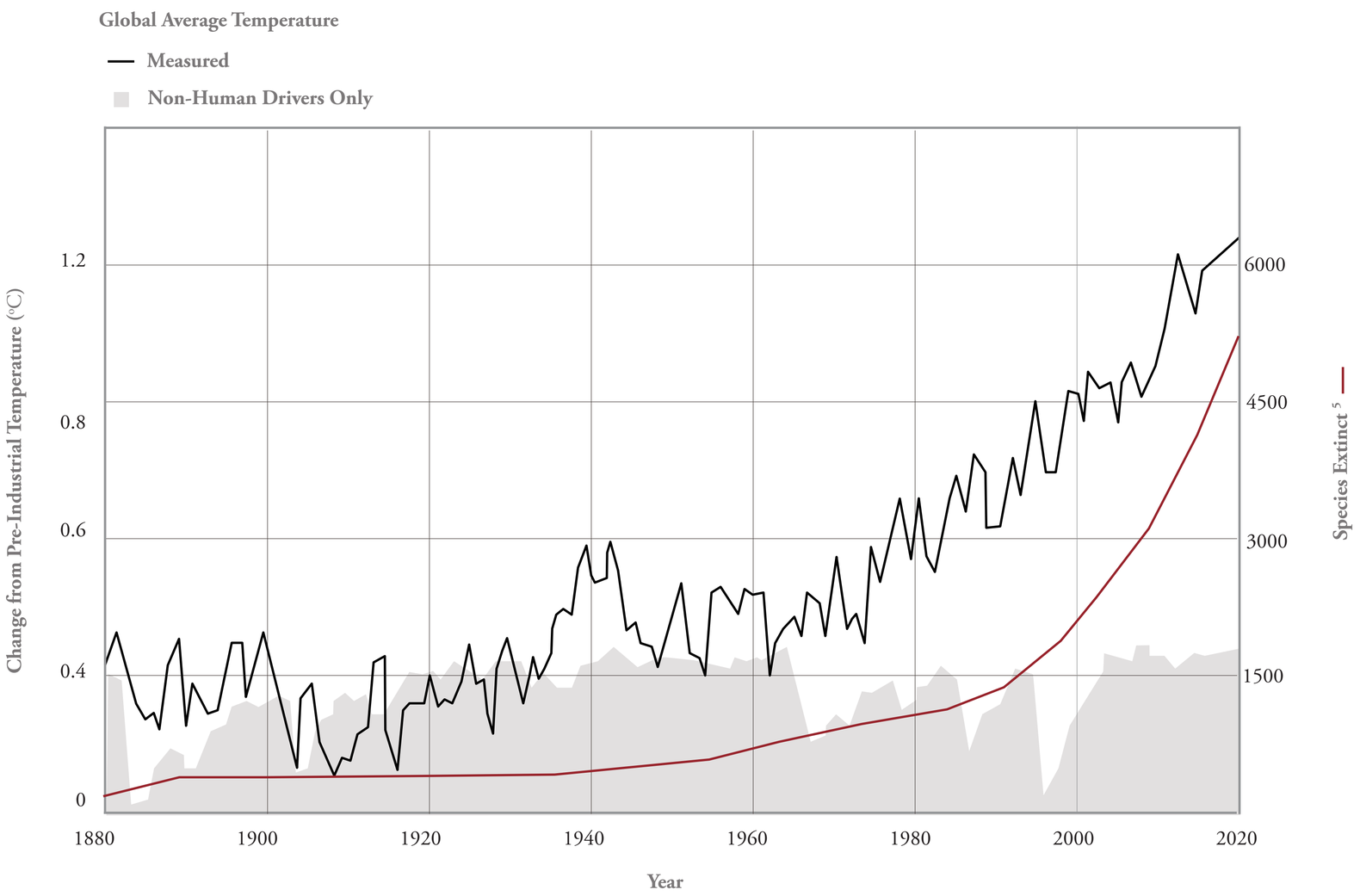
40

20

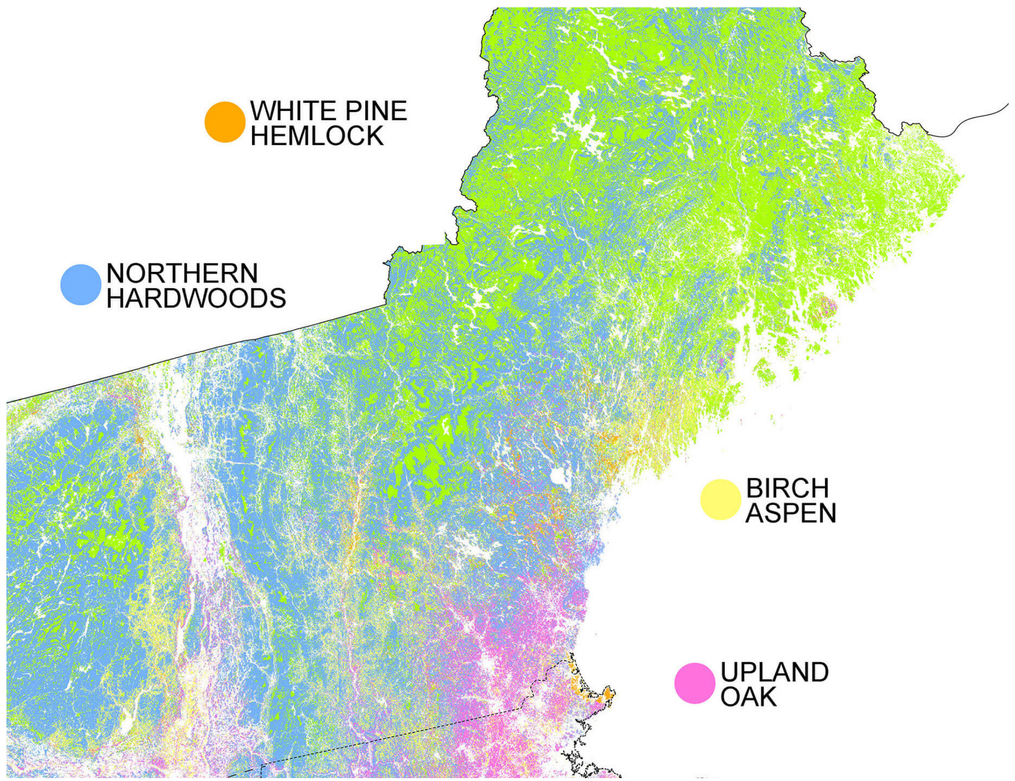
Daisies

- ● *Albedo = 0.25*
- ○ *Albedo = 0.75*

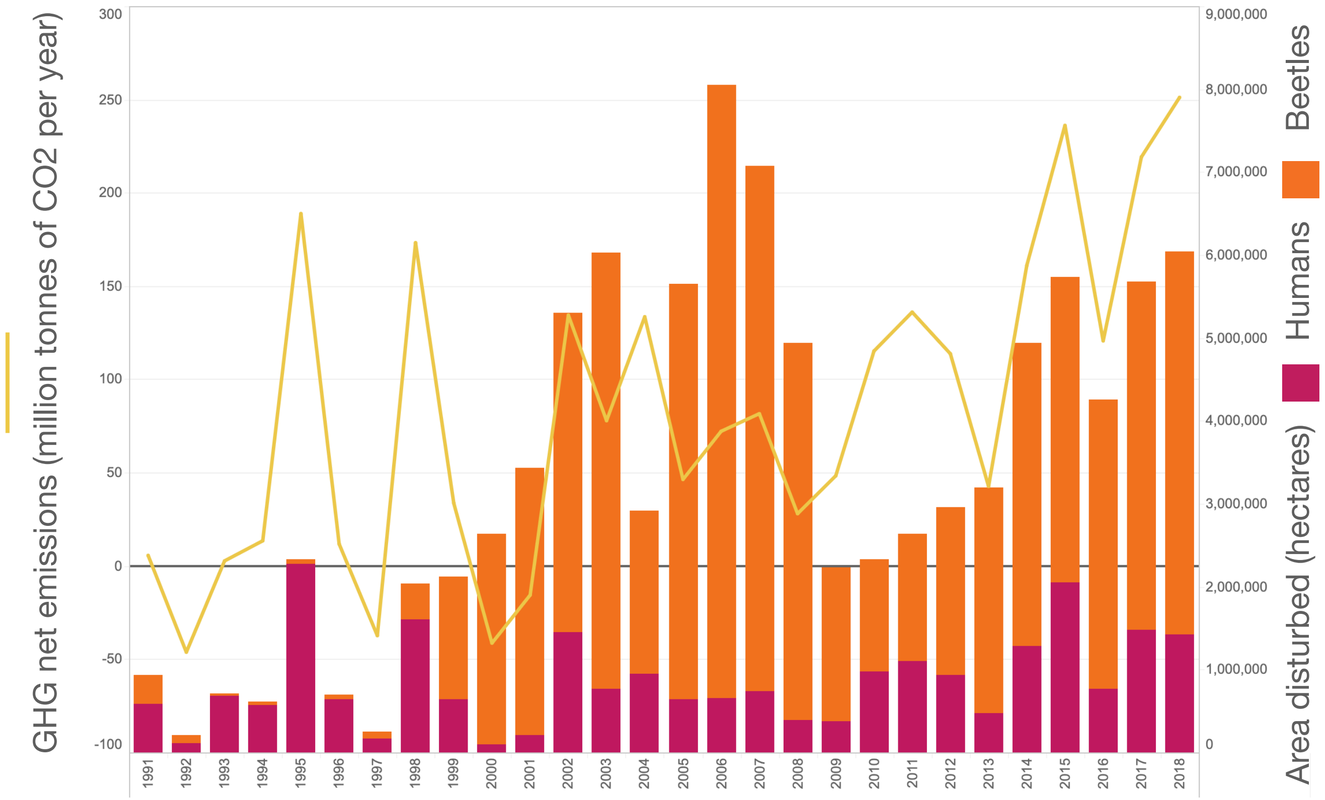
- ● *Ideal Reproduction Temp = 25°C*
- ○ *Ideal Reproduction Temp = 30°C*


Global Average Temperature
Measured
Non-Human Drivers Only
Change from Pre-Industrial Temperature (°C)
1.2
0.8
0.6
0.4
0
6000
4500
3000
1500
Species Extinct [5]
1880
1900
1920
1940
1960
1980
2000
2020
Year

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



Kiel Moe, There's More to Timber Building than Trees, The Architect's Newspaper, 2021.



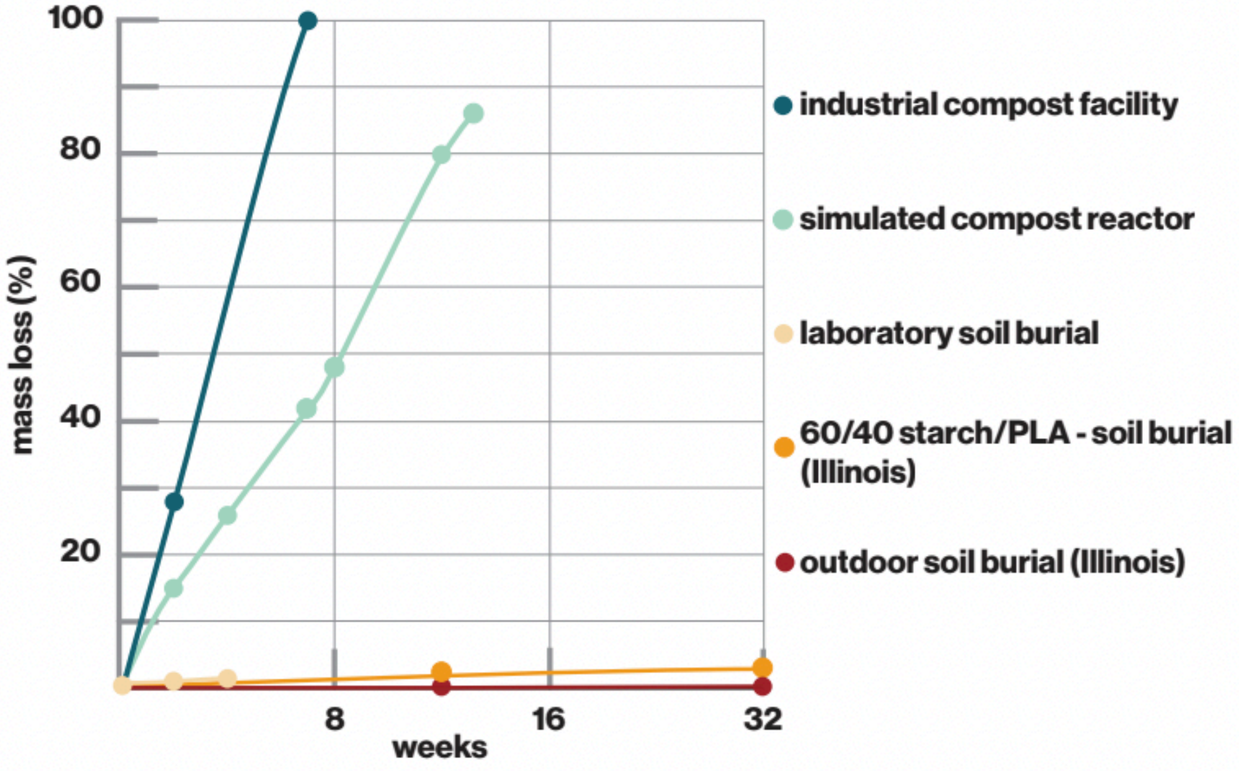
Indicator: Forest carbon emissions and removals , Government of Canada, 2020.

"Forests are the lungs of our planet, purifying the air and giving fresh strength to our people." -Franklin D. Roosevelt

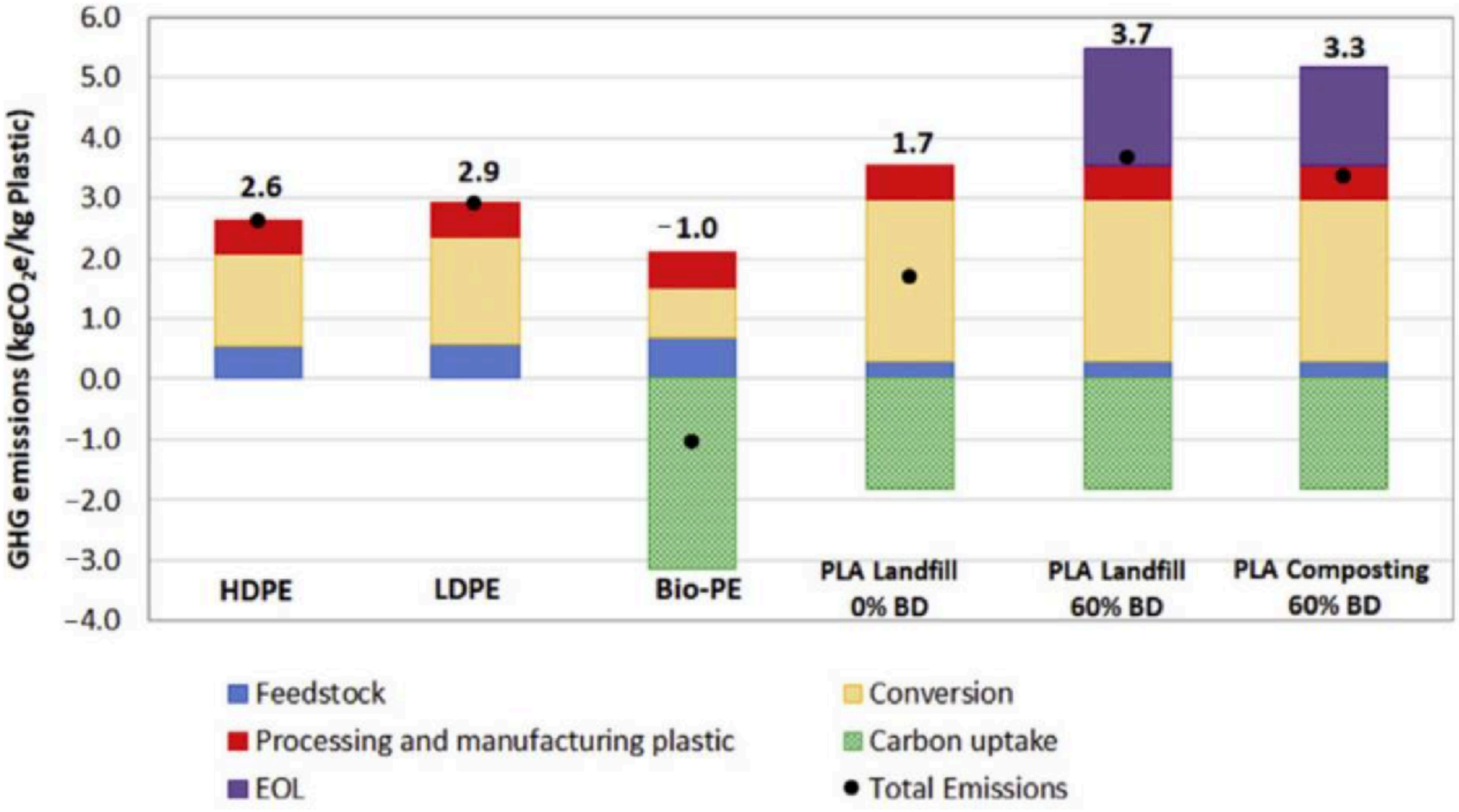
… "Oops."

YES FOR ECO
100% COMPOSTABLE

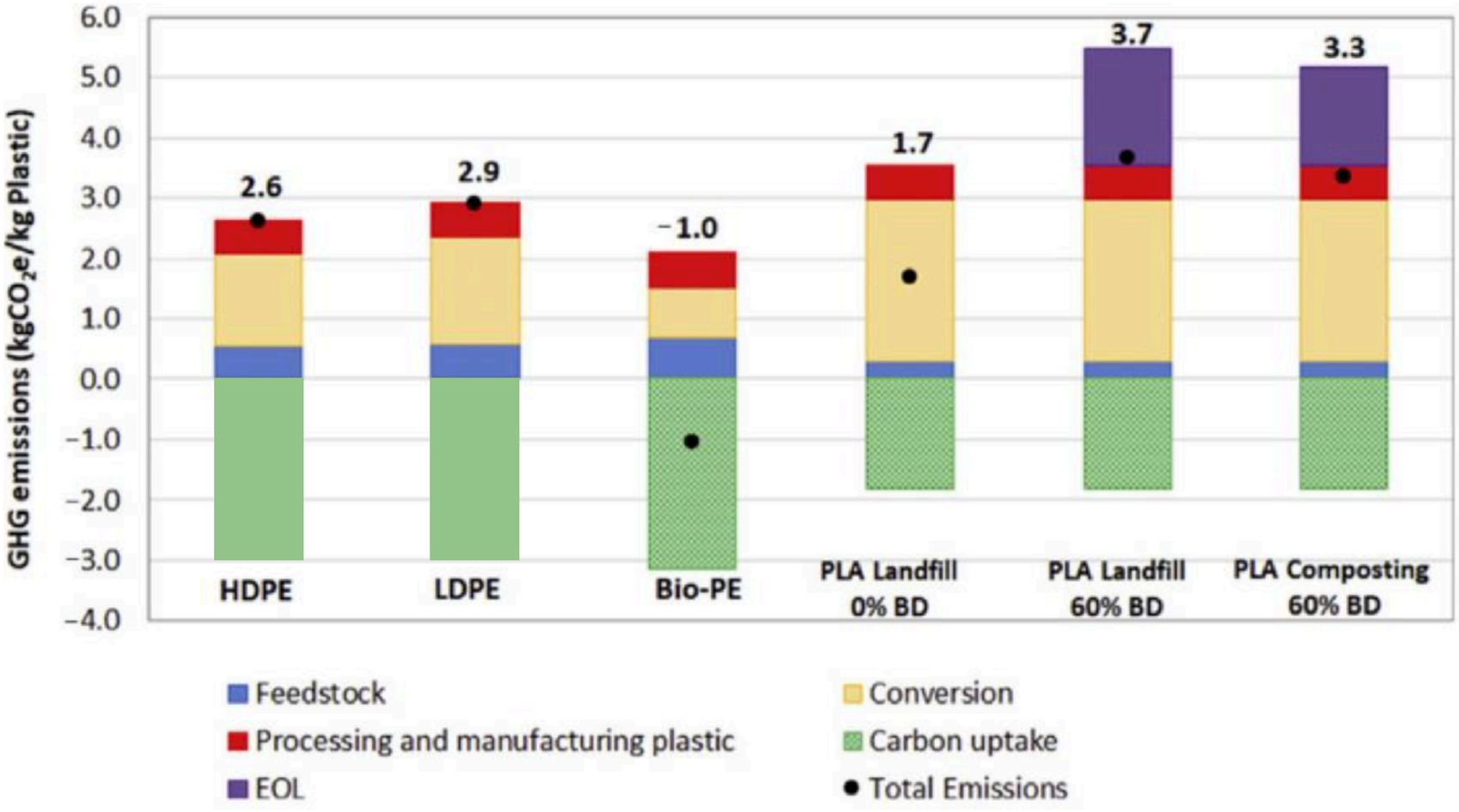
PLA Degradation



	industrial composter	ambient soil (Illinois)
temperature (˚C)	49-77	0-31
moisture content (%)	40-60	11-26
mechanical turning & oxygenation	yes	no



Rezvani Ghomi, E., Khosravi, F., Saedi Ardahaei, A., Dai, Y., Neisiany, R. E., Foroughi, F., ... & Ramakrishna, S. (2021). The life cycle assessment for polylactic acid (PLA) to make it a low-carbon material. Polymers, 13(11), 1854.



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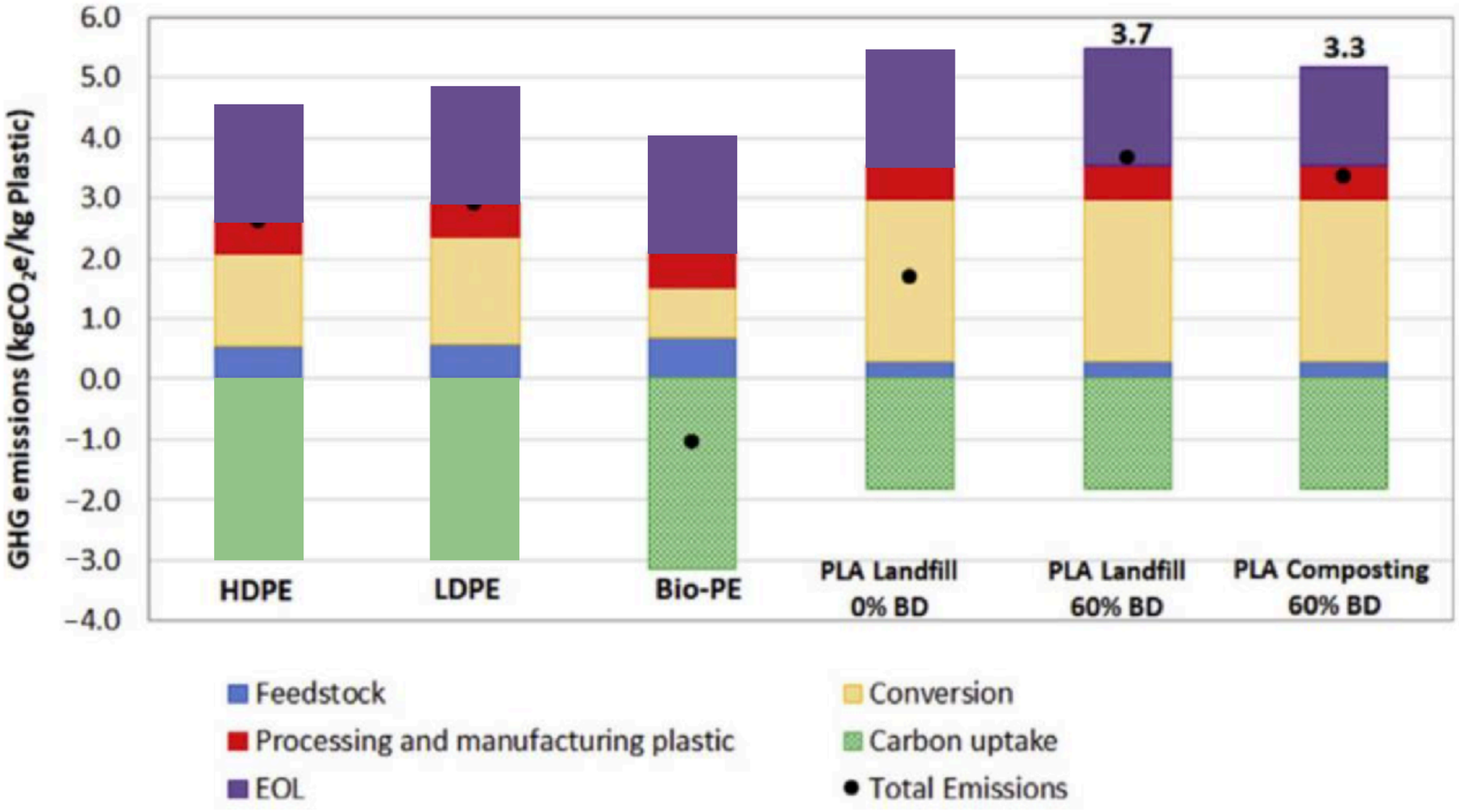

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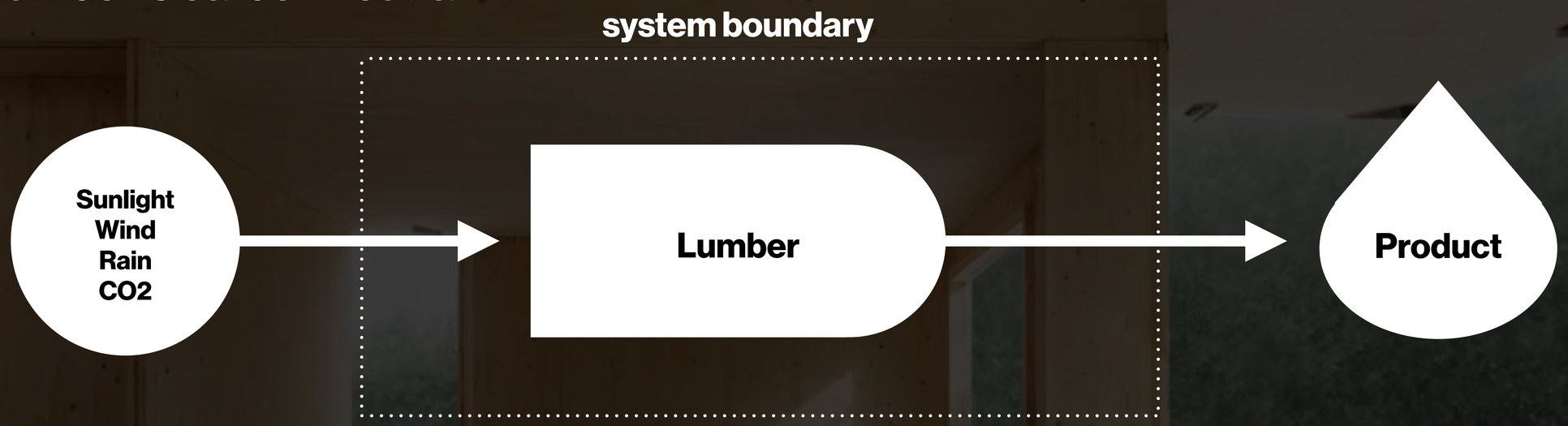
Sustainability is complicated...

Sustainability is complicated...

And we might be asking the wrong questions.

Claim 1: Lumber is carbon neutral.



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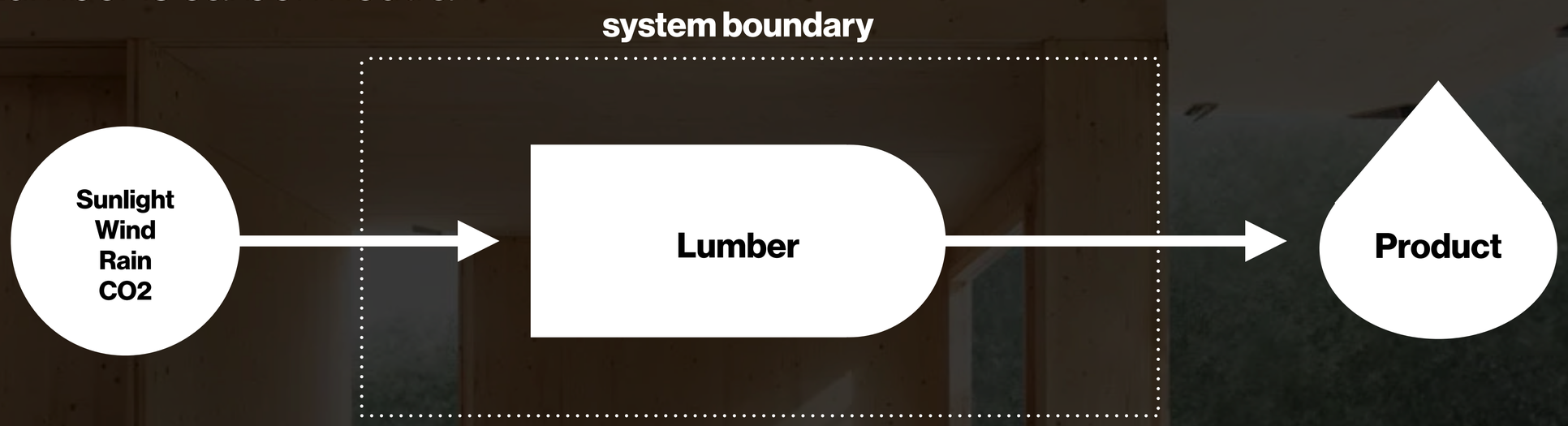
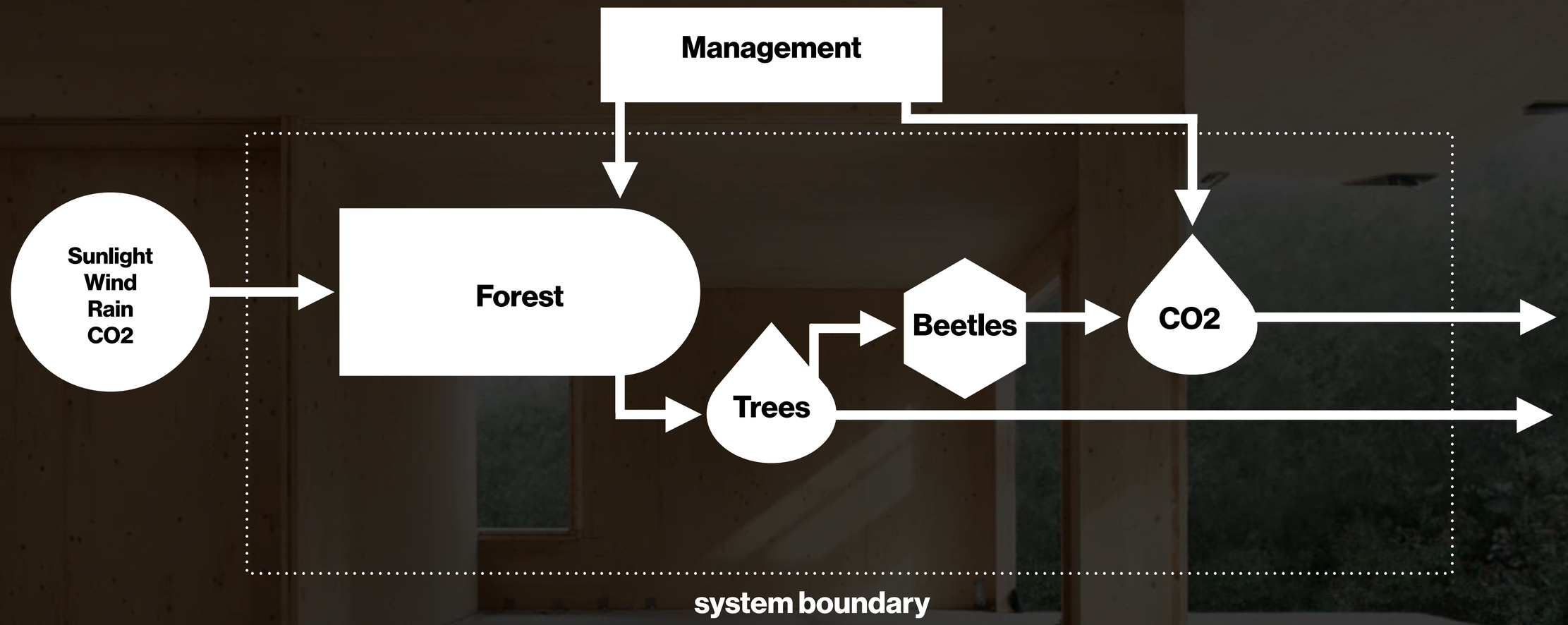


Evaluation: CO_2 in = CO_2 out

Claim 2: Lumber **might not be** carbon neutral.



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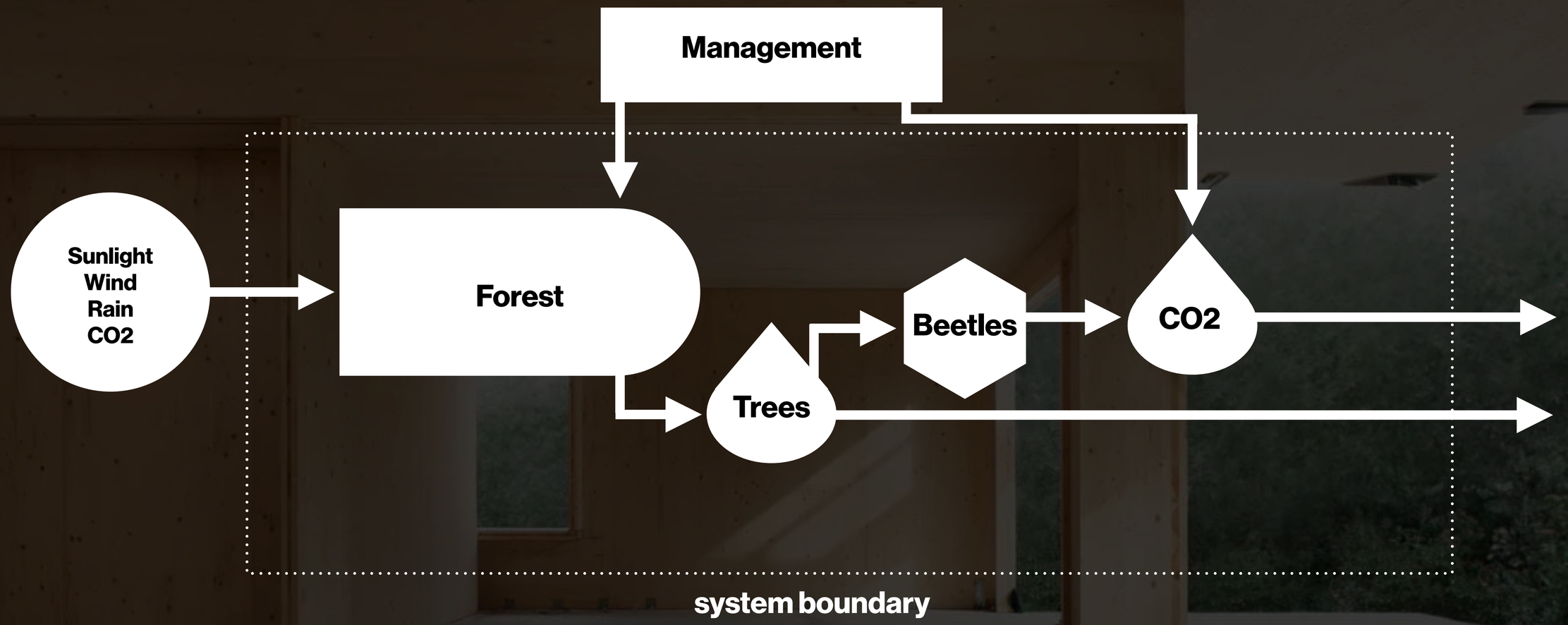

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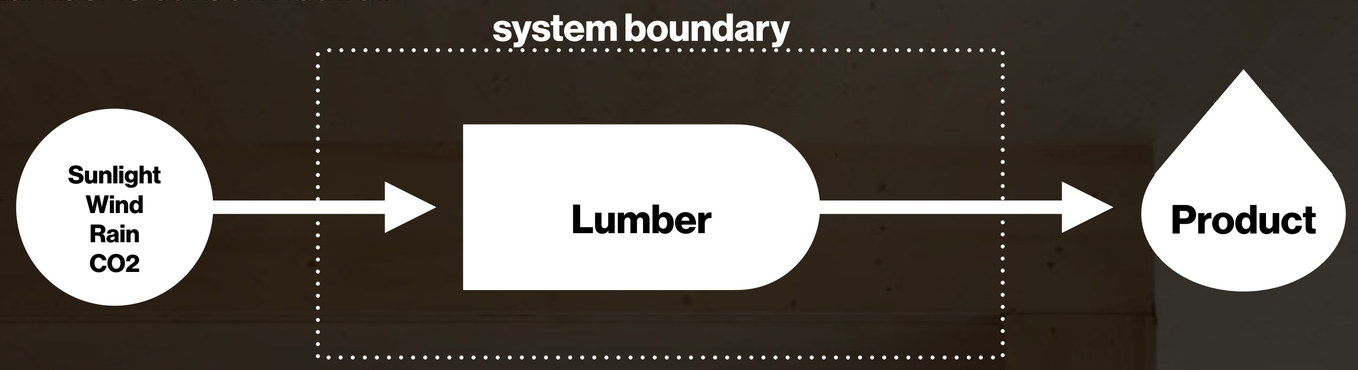

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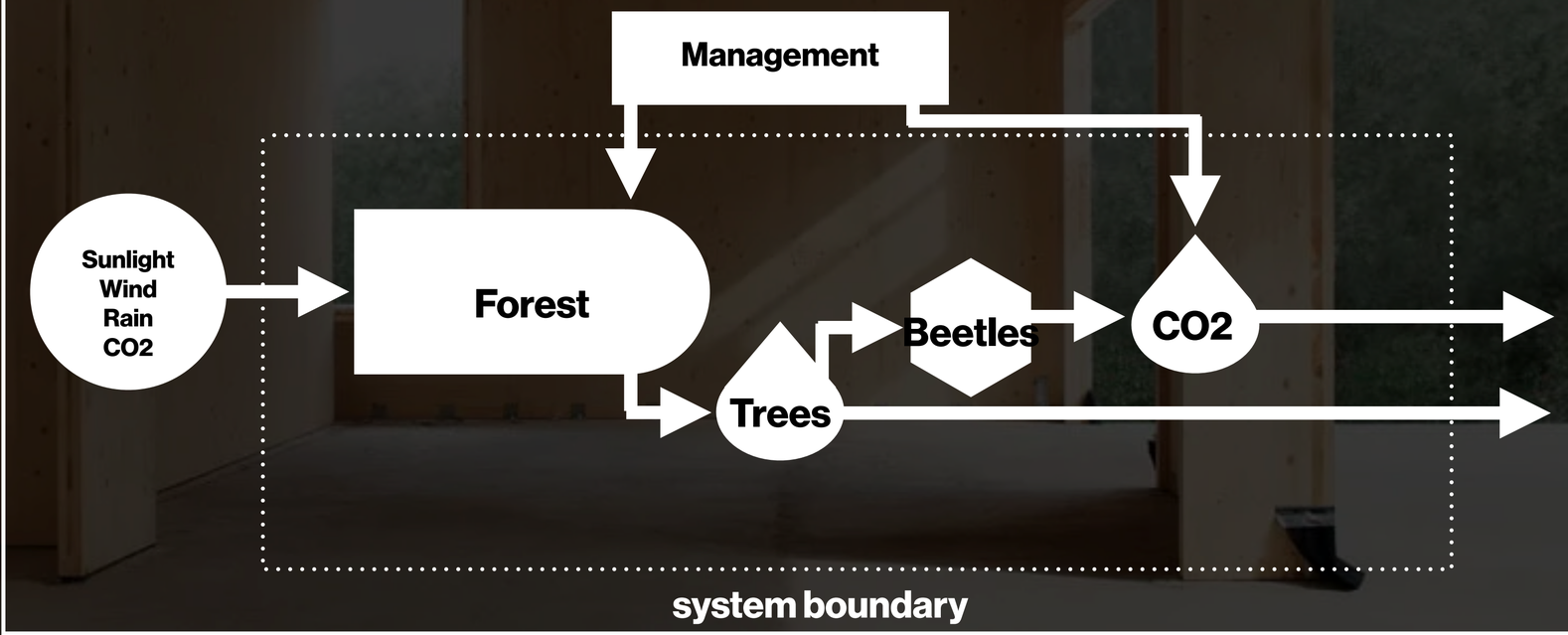
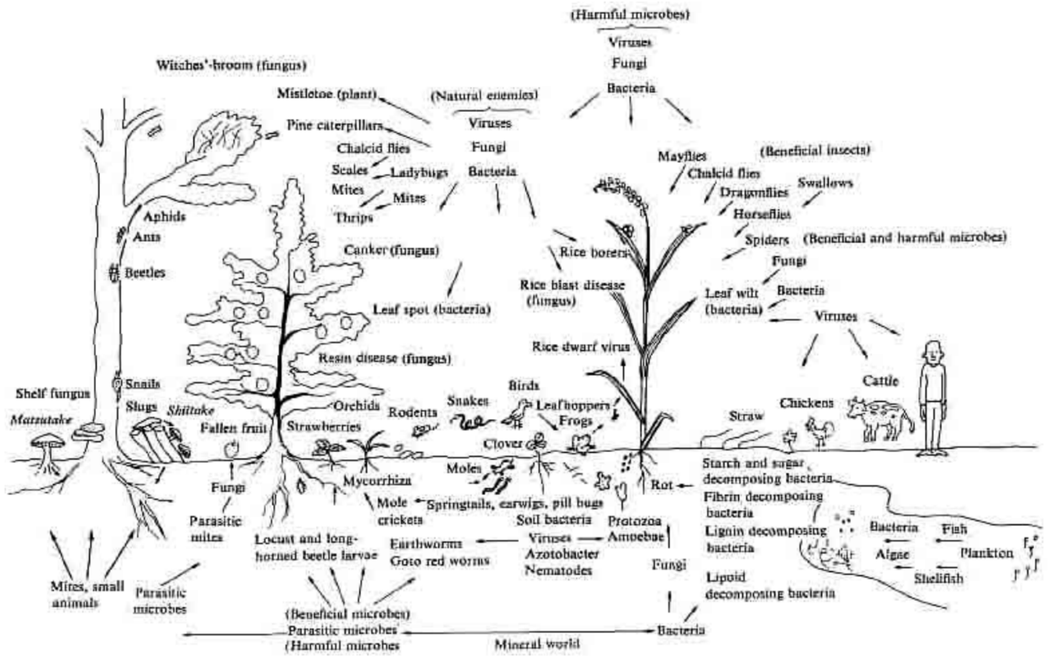


What are “the right” questions?

Critical Perspectives on Sustainable Design

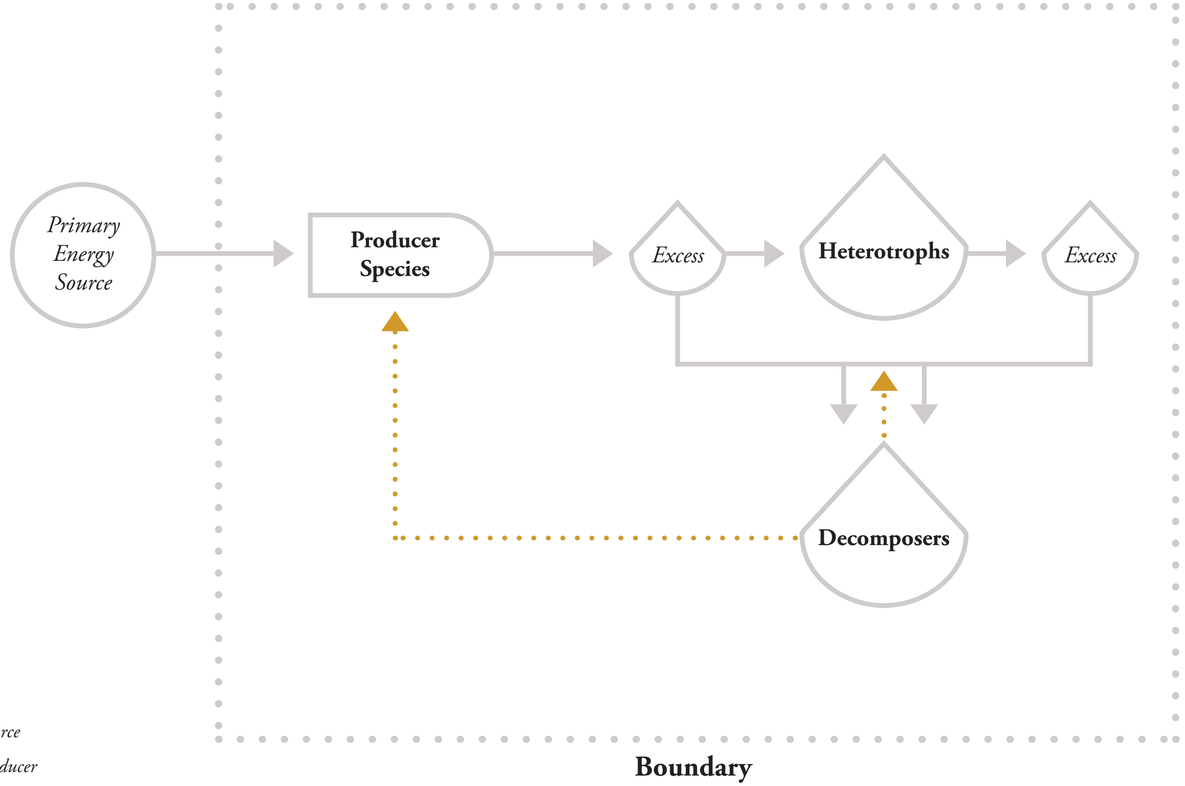
Fukuoka, M., Berry, W., Korn, L., Lappé, F. M. (2010). The One-Straw Revolution: An Introduction to Natural Farming. India: New York Review Books.

Fig.5.1 Cycles of the natural world

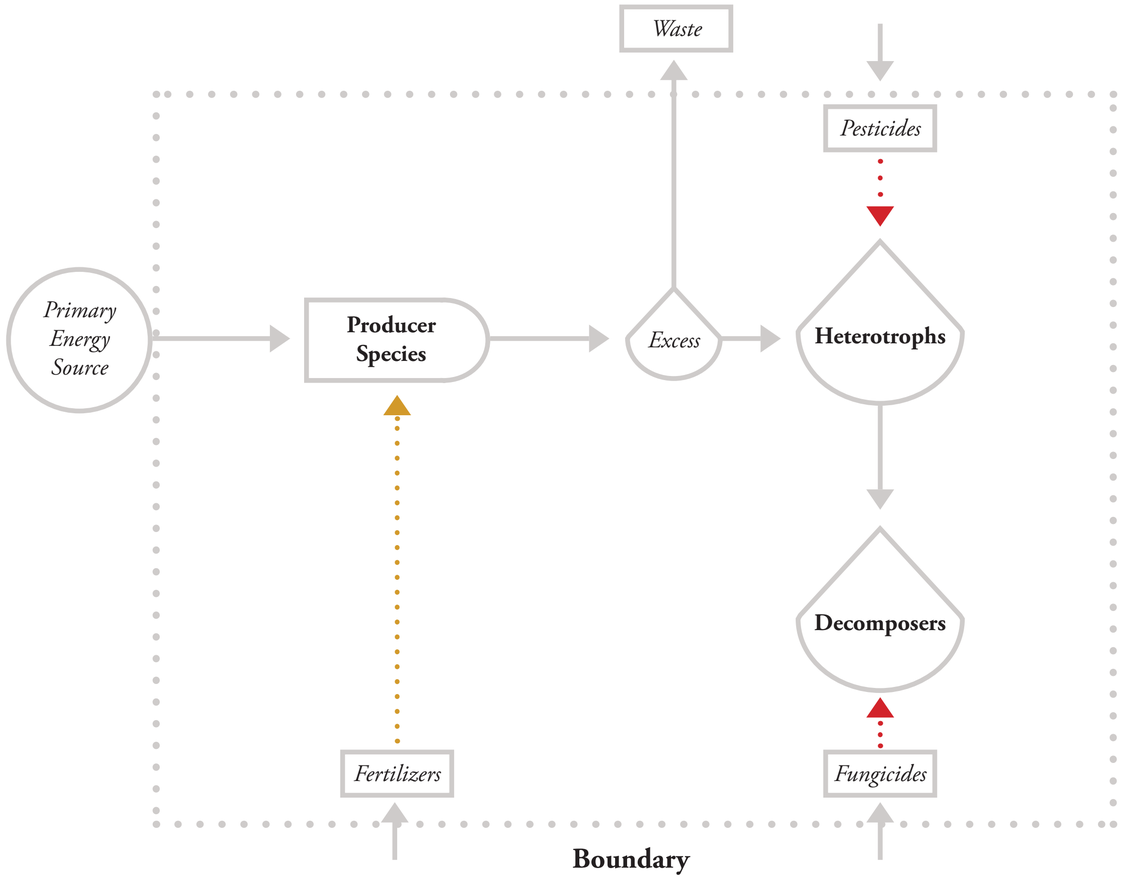


Fukuoka, M. (1985). The natural way of farming. Tokyo: Japan Publications.

Natural Farming



Conventional Farming



- *Source*
- *Producer*
- *Storage*
- *Miscellaneous*
- *Positive Feedback*
- *Negative Feedback*

Sustainability is complicated...

but possible.

What is

sustainability /

design /

this class /

me /

you /

What is
sustainability /
design /
this class /
me /
you /

This class is about...

Breaking big questions down into smaller questions.

Quantifying metrics related to those questions.

Proposing designs based on those metrics.

What is
sustainability /
design /
this class /
me /
you /

You will *not* often hear me say...

Definitely!

X is more sustainable than Y!

Doing X would solve Y problem!

What is
sustainability /
design /
this class /
me /
you /

You will often hear me say...

That's complicated...

I'm not sure...

Well, maybe...

Embrace nuance.

Critical Perspectives on Sustainable Design

Date	Topic	Assigments
1/10	What is sustainability? What is design?	Select project topic
1/12	What is sustainability? What is design?	Literature review of topic
1/17	Critical evaluation of sustainable (?) designs	Project proposal
1/19	Critical evaluation of sustainable (?) designs	Mid-term presentations
1/24	Designing sustainable systems	Project check-in
1/26	Designing sustainable systems	Final project presentations

Critical Perspectives on Sustainable Design

Assigment	Grade Proportion
Project proposal	10%
Mid-term presentation	15%
Final presentation	15%
Analysis portfolio	40%
Participation	20%

Critical Perspectives on Sustainable Design

Course project:

1. Choose a design (product, system, policy) that you care about.

Critical Perspectives on Sustainable Design

Course project:

1. Choose a design (product, system, policy) that you care about.
2. Describe how the design interacts with the environment.

Critical Perspectives on Sustainable Design

Course project:

1. Choose a design (product, system, policy) that you care about.
2. Describe how the design interacts with the environment.
3. Propose how that design could be changed to improve environmental interactions.

Critical Perspectives on Sustainable Design

What is

sustainability /

design /

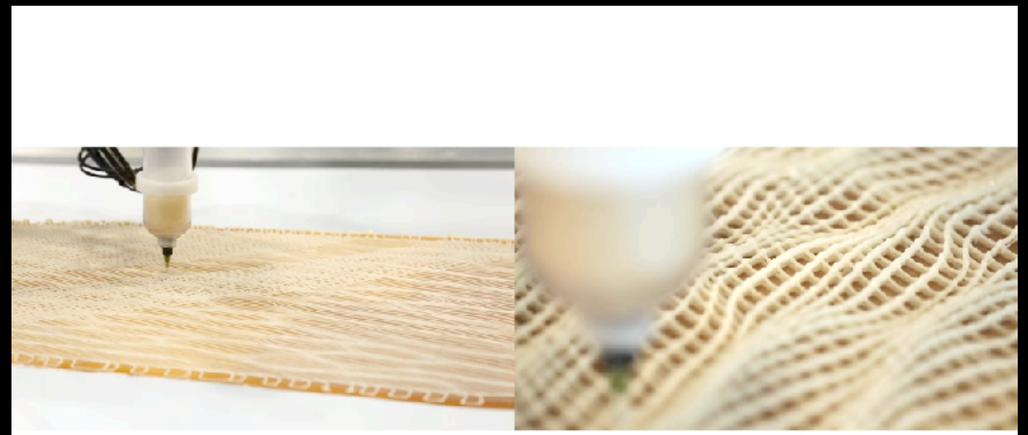
this class /

me /

you /

I am a...

computational designer, material ecologist



What is

sustainability /
design /
this class /
me /
you /

I am a...

computational designer, material ecologist

What is

sustainability /

design /

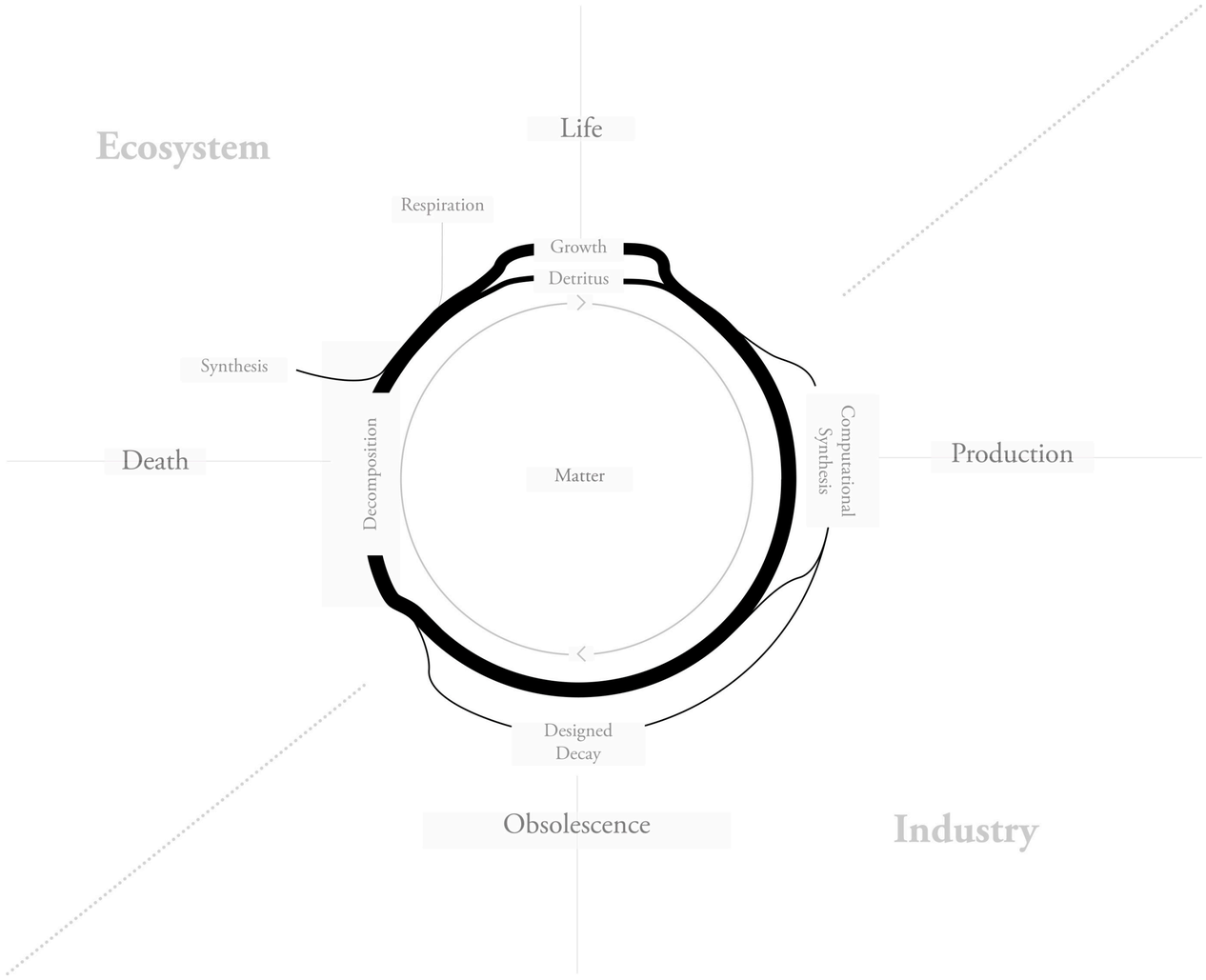
this class /

me /

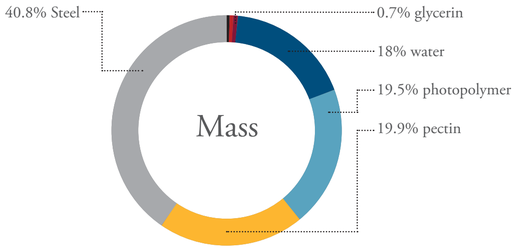
you /

I am a...

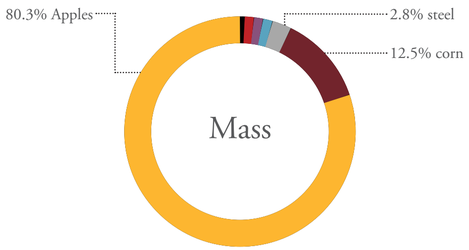
computational designer, material ecologist


Ecosystem
Life
Respiration
Growth
Detritus
Synthesis
Death
Decomposition
Matter
Computational Synthesis
Production
Designed Decay
Obsolescence
Industry

Aguahoja II Components



Aguahoja II Resources



Aguahoja II Planetary System Map

Emergy Evaluation for Aguahoja II

Yield

3.71 E+17 sej

Organic Materials
3.17 E+17 sej

Synthetic Materials
2.90E+15 sej

Renewable Inputs
4.38E+14 sej

Electricity and Fuel
2.85E+13 sej

Biproducts (biodeisel, food products)
8.50E+15 g

%Renewability

13% Renewable

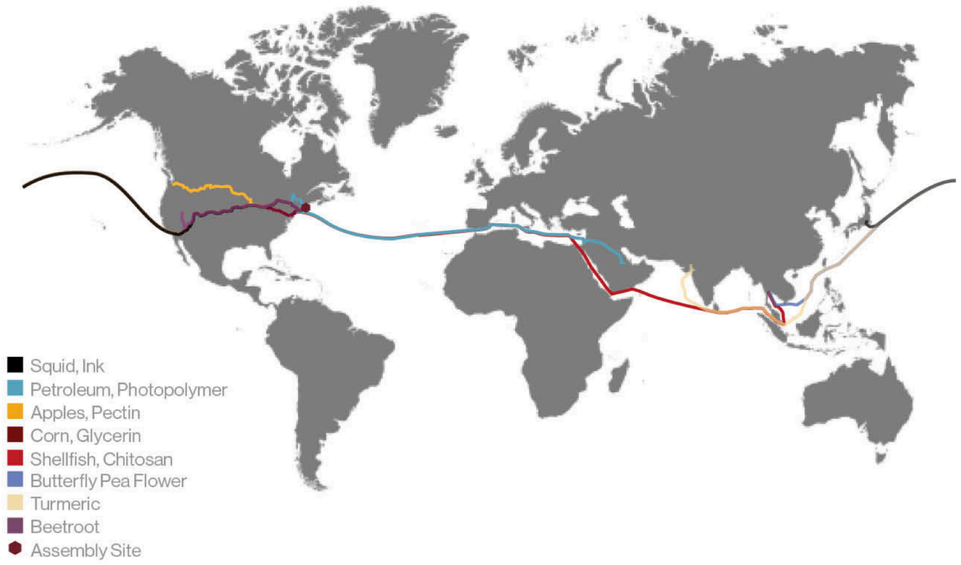
Renewable Inputs
4.38 E+14 sej

Yield
3.71 E+17 sej

13% Renewable

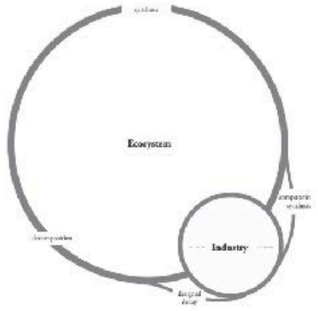
Territory

8.90 E+04 km



sej = solar emjoules

framework



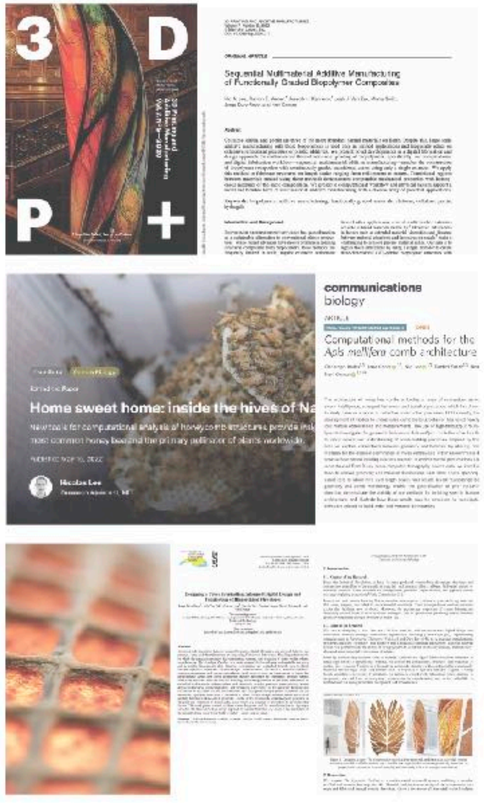
I. Environmental Modeling

II. Computational Synthesis

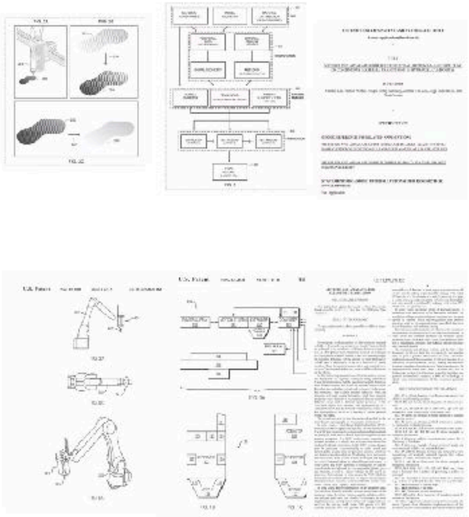
III. Designed Decay

design & arts

science & knowledge



technology



What is
sustainability /
design /
this class /
me /
you /

I am not...

An expert in nonlinear thermodynamics
Deeply experienced with LCA
An environmental scientist
An architect
Etc.

What is
sustainability /
design /
this class /
me /
you /

You are...

Encouraged to ask hard questions
Get in over your head
Dive too deeply
Question your assumptions

Critical Perspectives on Sustainable Design

Break
(15 min)

What is sustainability?

What is design?

What is sustainability?

Sustainable development "meets the needs of the present without compromising the ability of future generations to meet their own needs".

United Nations, 1983

SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
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SUSTAINABLE DEVELOPMENT GOALS

ESG
ENVIRONMENTAL
Climate change strategy,
Biodiversity,
Water efficiency,
Energy efficiency,
Carbon intensity,
Enviromental
management system
SOCIAL
Equal opportunities,
Freedom of association,
Health and safety,
Human rights,
Customer &
products resposibility,
Child labour
GOVERNANCE
Business ethics,
Compliance,
Board independence,
Executive compensation,
Shareholder democracy

What is sustainability?

"no country is delivering what its citizens need without transgressing the biophysical planetary boundaries"

Unlocking a Better Future, 2020

What is sustainability?

Sweetgrass, Shinto temples

What is sustainability?

Sustainable development "meets the needs of the present without compromising the ability of future generations to meet their own needs".

United Nations, 1983

"It sounds like they want to find ways to keep taking."

Potawatomi Elder, Braiding Sweetgrass

What is sustainability?

(2min)

What do *you* think sustainability means?

What is sustainability?

(2min)
What do *you* think sustainability means?

(3min)
Partner off, discuss your definitions. Do you agree?

What is sustainability?

(2min)
What do *you* think sustainability means?

(3min)
Partner off, discuss your definitions. Do you agree?

(3min)
Share your collaborative definition with the class.

Plastic Waste - Var Uta

What is unsustainability?

What is unsustainability?

Existential Threats

GHG emissions, resource scarcity

What is unsustainability?

Existential Threats
GHG emissions, resource scarcity

Unequal Exchange
Impoverishing others for our benefit

What is unsustainability?

Existential Threats
GHG emissions, resource scarcity

Unequal Exchange
Impoverishing others for our benefit

Negative Feedback
Pollution, over extraction

What is sustainability?

Other considerations

Timescale

Geological scale

i.e. system boundaries

What is sustainability?

“Entering into reciprocity with the land.”

Potawatomi elder on sustainability.

What is sustainability?

“Entering into reciprocity with the land.”
Potawatomi elder on sustainability.

What is sustainability?

“Entering into reciprocity with the land.”
Potawatomi elder on sustainability.

The continued existence of the human race.
A literal interpretation of terms.

What is sustainability?

“Entering into reciprocity with the land.”
Potawatomi elder on sustainability.

The continued existence of the human race.
A literal interpretation of terms.

Anything that increases biodiversity is sustainable.
Anything that decreases biodiversity is unsustainable.
Me, taking a shot in the dark.

What is sustainability?

I don't *really* have an answer for you.

What is design?

What is design?

Design is the process of assigning form to media in order to solve problems.

-me.

What is design?

Graphic Designers
Shape pixels to address user needs.

Architects
Shape materials to provide shelter.

Farmers
Shape landscapes to provide sustenance.

What is design?

Products

An item or service that addresses a need.

What is design?

Products
An item or service that addresses a need.

Systems
The infrastructure that outputs products.

What is design?

Products
An item or service that addresses a need.

Systems
The infrastructure that outputs products.

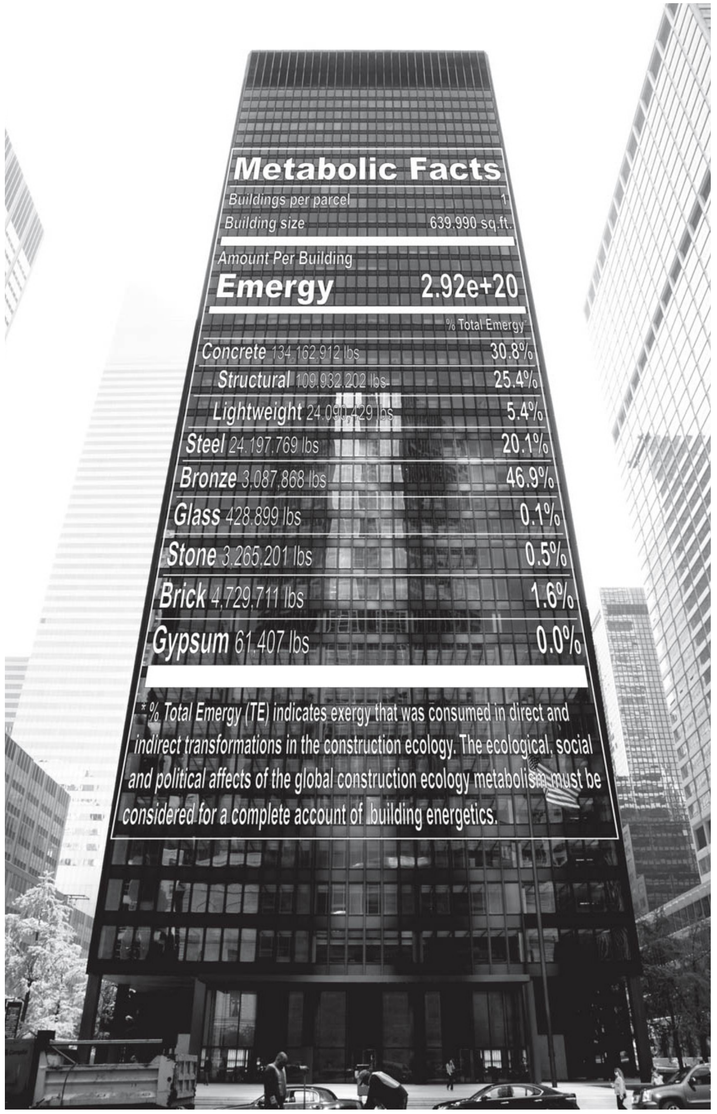
Policies
The boundaries we place on systems.

Why designers?

Why designers?

Where do resources come from?

Where do they go?



Unless: The Seagram Building Construction Ecology. (2021). Spain: Actar D.v

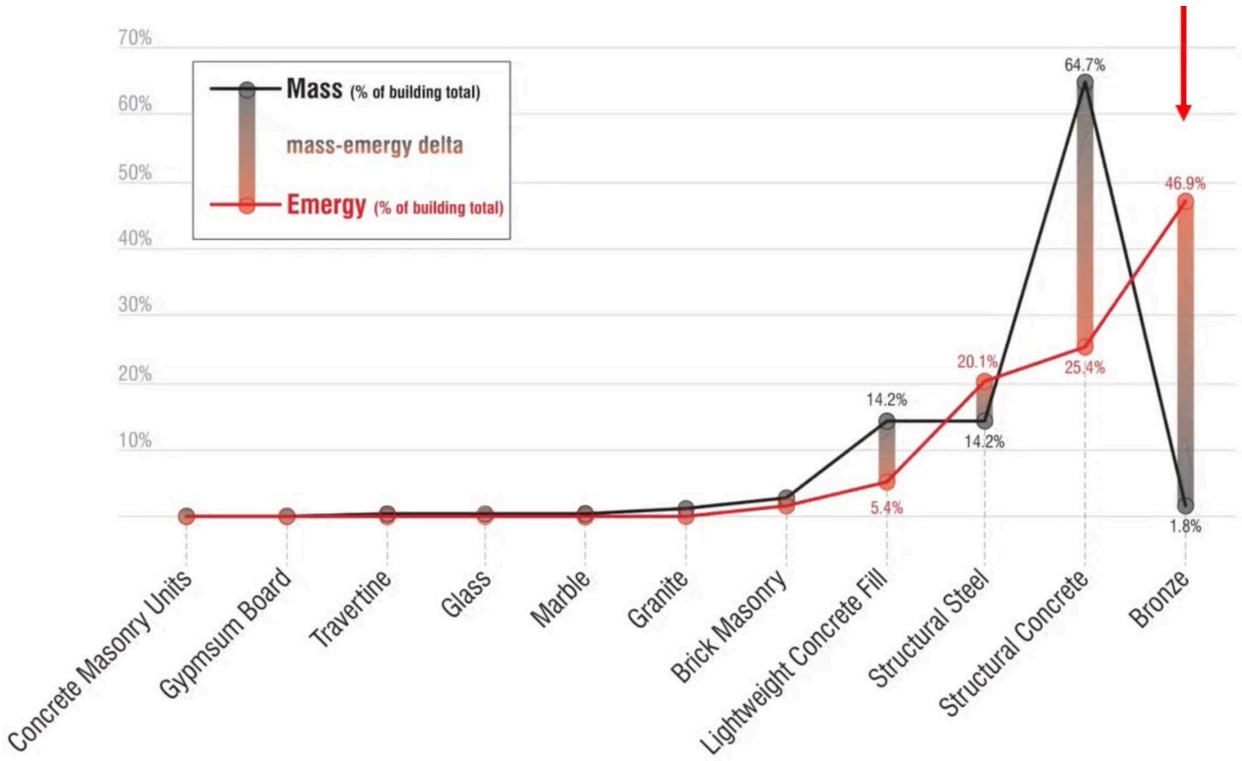
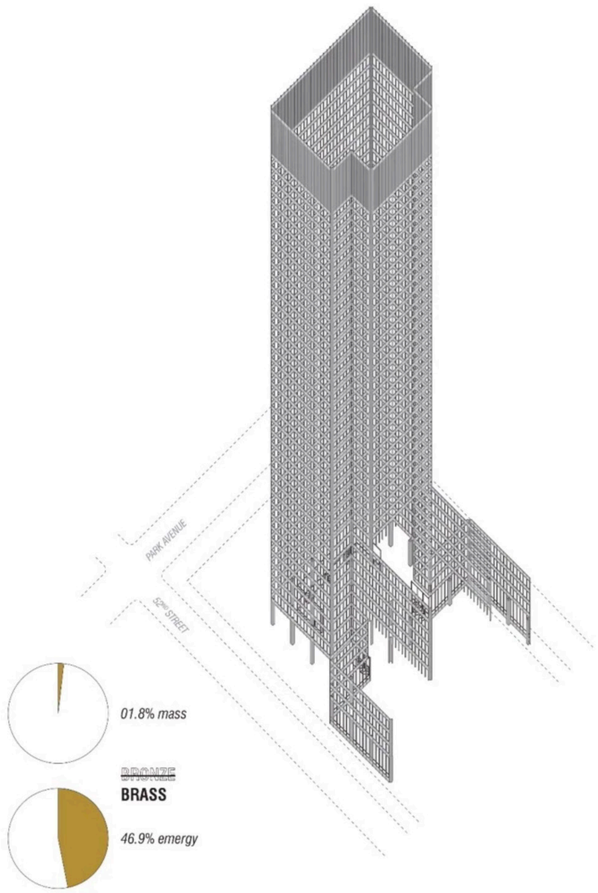
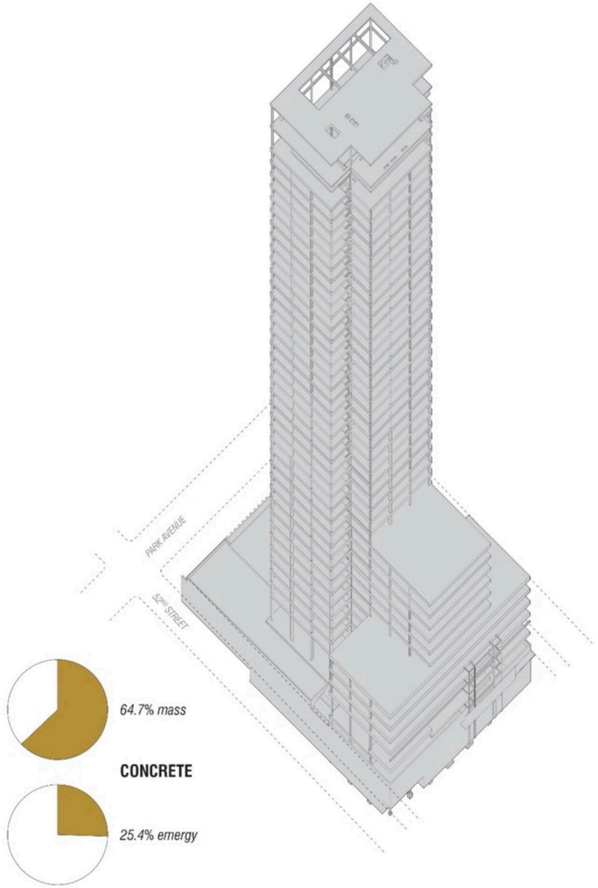


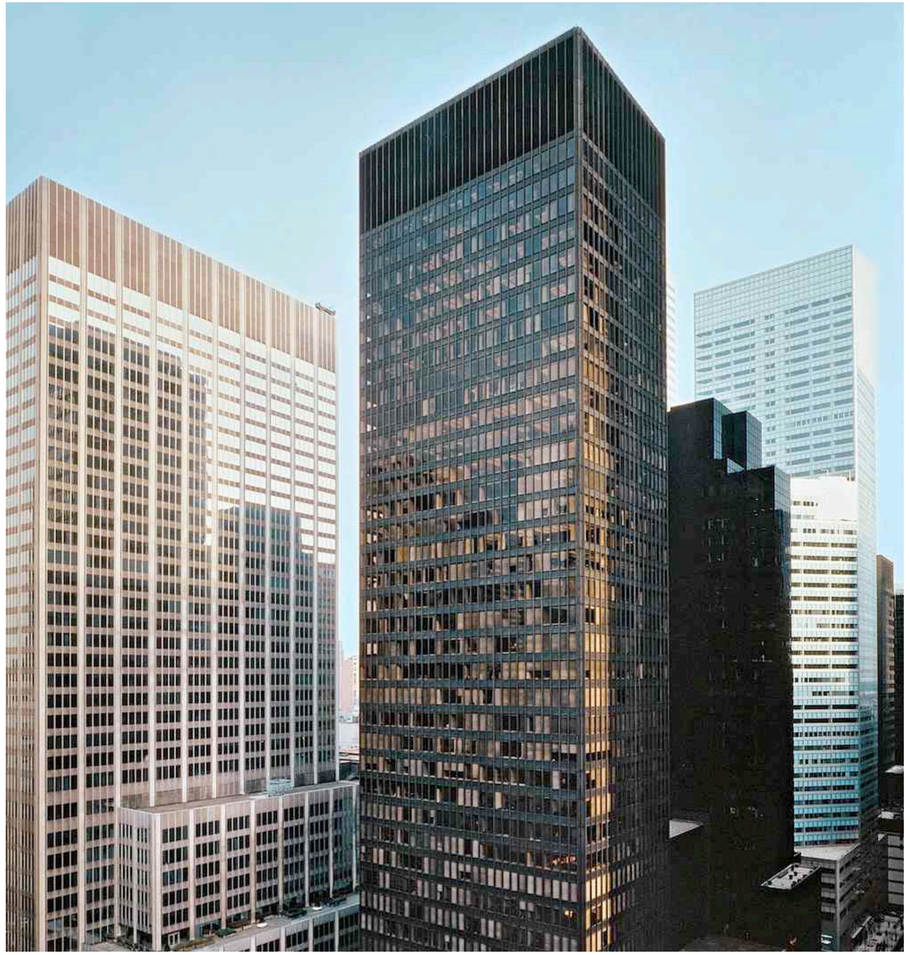
Fig. 4.28: Seagram Building Material Mass & Emergy Quantities





Unless: The Seagram Building Construction Ecology. (2021). Spain: Actar D.

The Seagram Building



The Seagram *Building*

Unless: The Seagram Building Construction Ecology. (2021). Spain: Actar D.

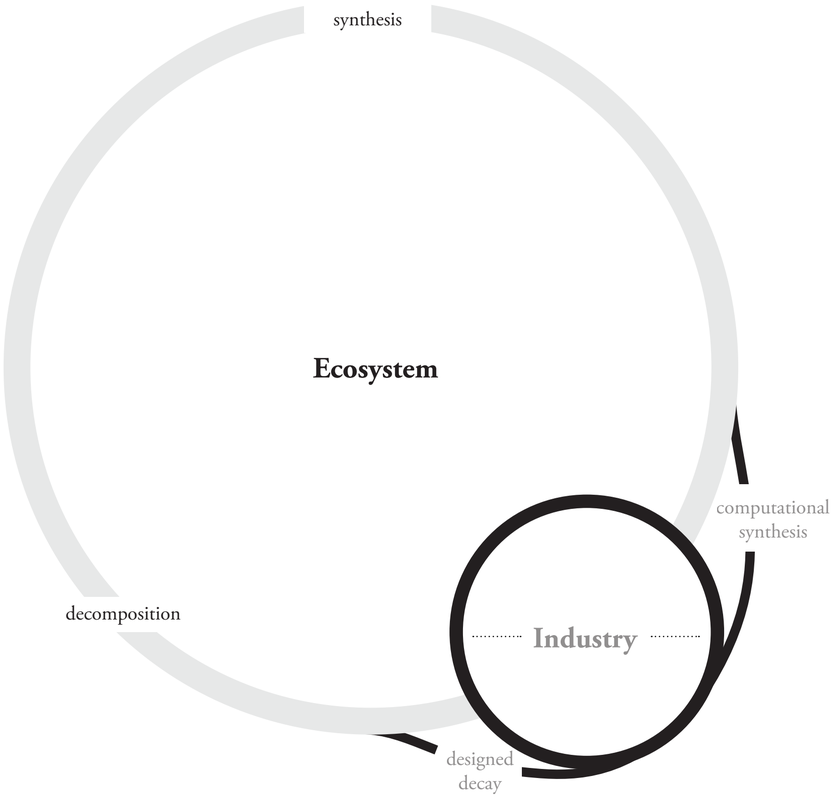
Gilles Perraudin, Lyon, France.

Break
(15 min)

Discussion 1:

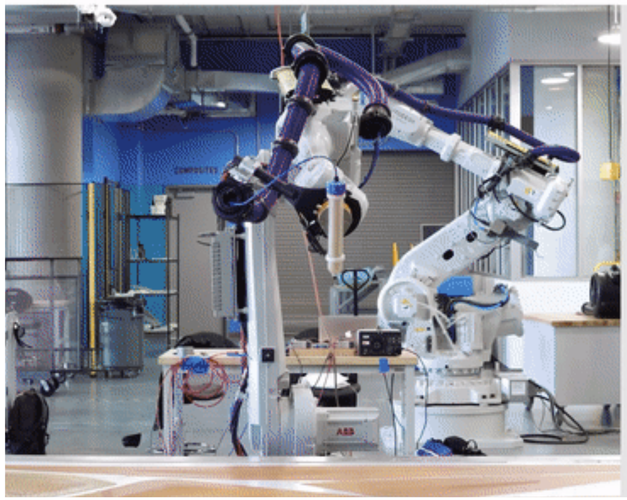
Is Aguahoja sustainable?

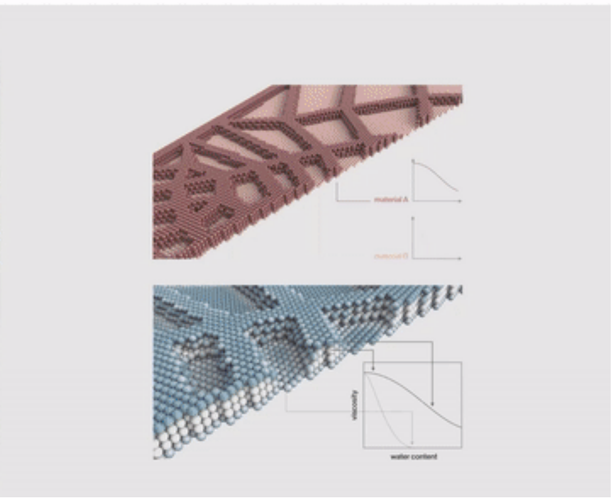
Aguahoja I



Computational Synthesis

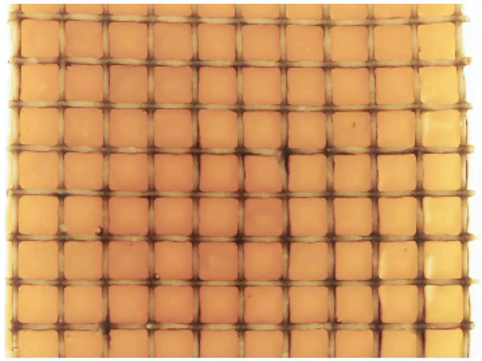
How can we access the veratility of organic materials?

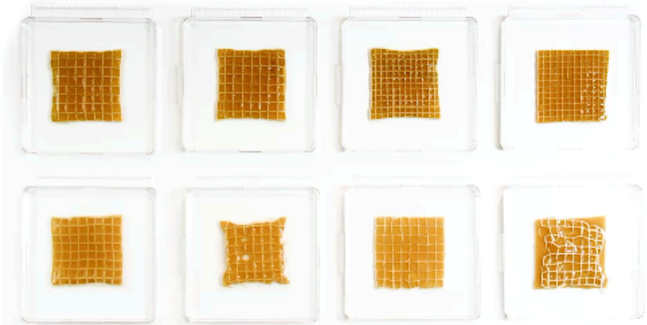




Designed Decay

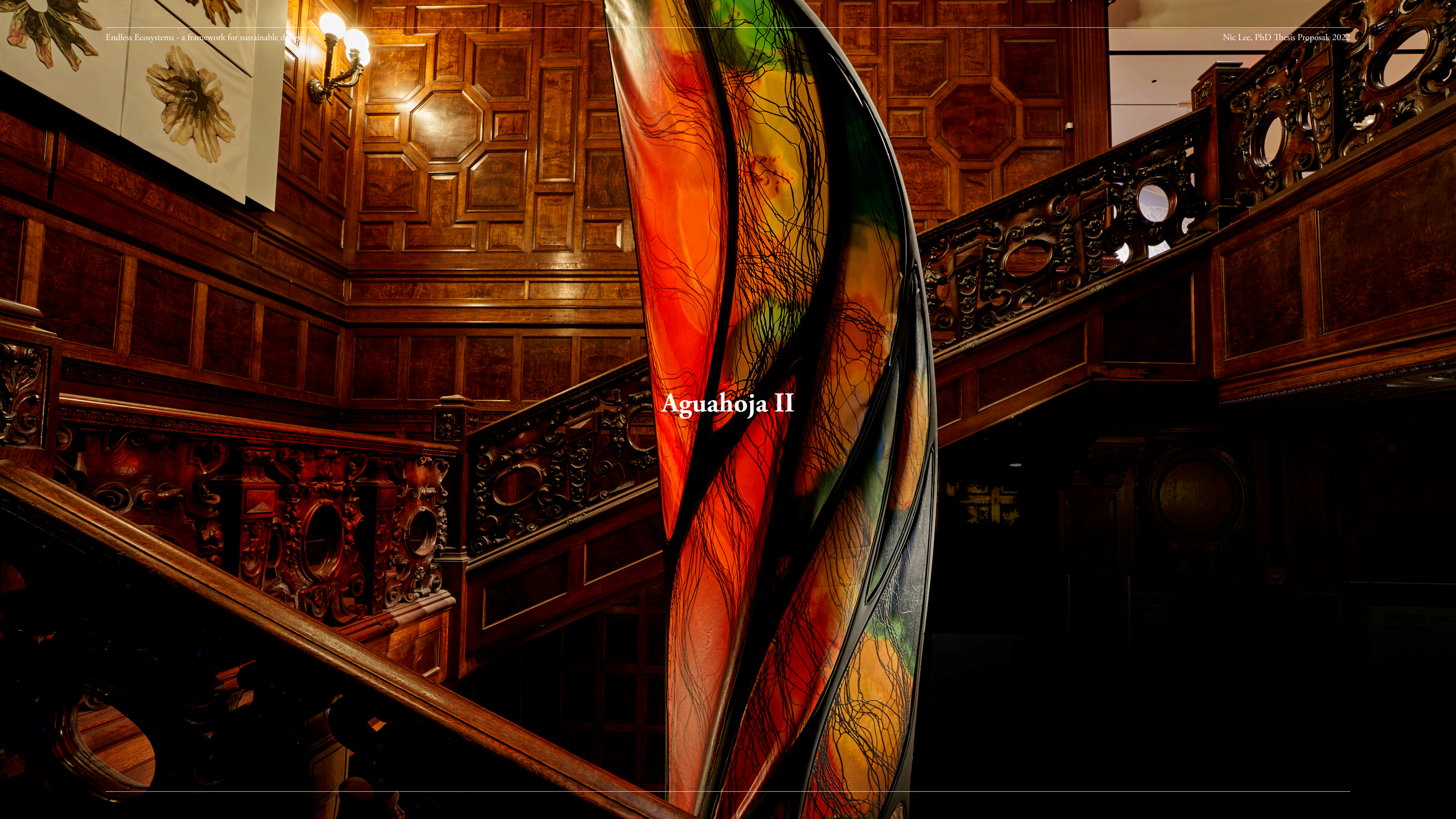
How can we return an object's energy to the environment?





Aguahoja

Photography: Oxman


Aguahoja II

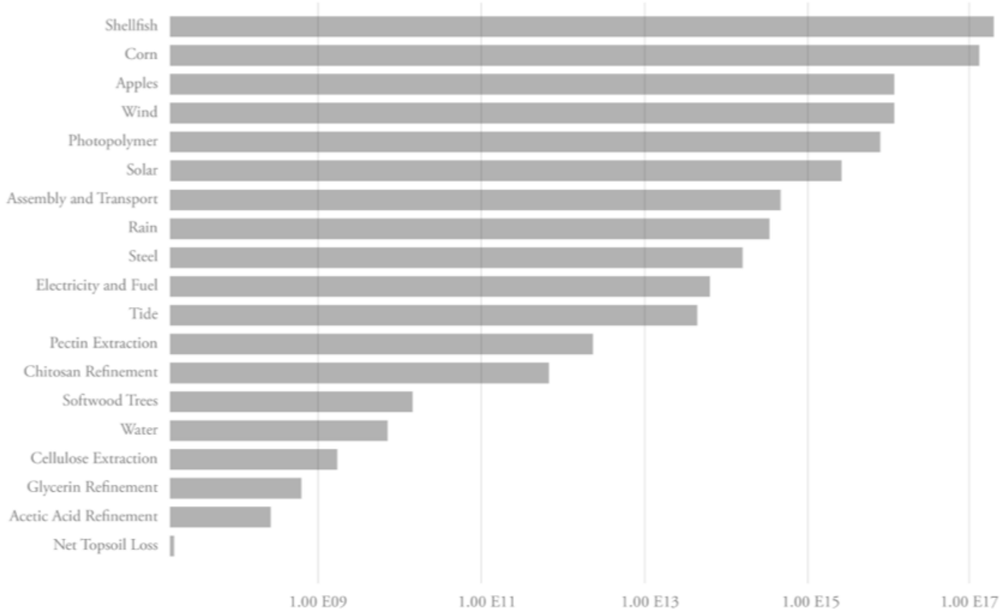
Aguahoja III

ature x
umanity
XMAN
rchitec

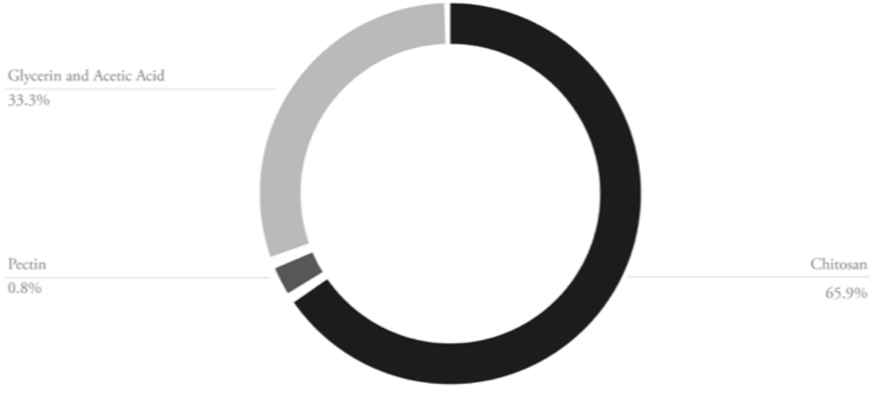
Planetary Material Map for *Aguahoja*

Planetary Material Map for *Aguahoja II*

A

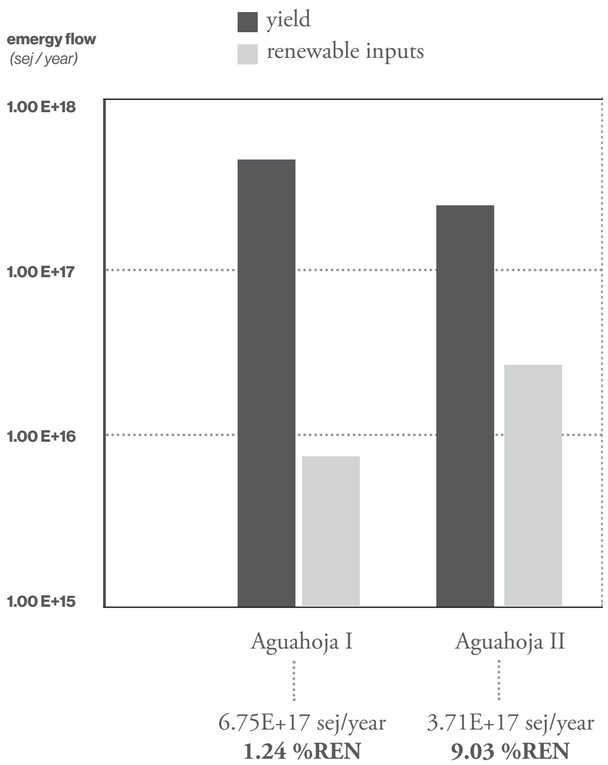

Shellfish
Corn
Apples
Wind
Photopolymer
Solar
Assembly and Transport
Rain
Steel
Electricity and Fuel
Tide
Pectin Extraction
Chitosan Refinement
Softwood Trees
Water
Cellulose Extraction
Glycerin Refinement
Acetic Acid Refinement
Net Topsoil Loss
1.00 E09
1.00 E11
1.00 E13
1.00 E15
1.00 E17

B

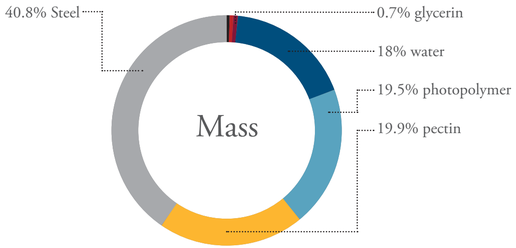

Glycerin and Acetic Acid
33.3%
Pectin
0.8%
Chitosan
65.9%

C

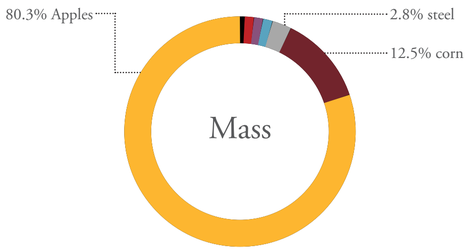
Robot
Computation
Blender
Air Compressor
5.00E+06
1.00E+07
5.00E+07
1.00E+08


yield
renewable inputs
emergy flow
(sej / year)
1.00 E+18
1.00 E+17
1.00 E+16
1.00 E+15
Aguahoja I
Aguahoja II
6.75E+17 sej/year
1.24 %REN
3.71E+17 sej/year
9.03 %REN

Aguahoja II Components



Aguahoja II Resources



Aguahoja II Planetary System Map

Emergy Evaluation for Aguahoja II

Yield

3.71 E+17 sej

Organic Materials
3.17 E+17 sej

Synthetic Materials
2.90E+15 sej

Renewable Inputs
4.38E+14 sej

Electricity and Fuel
2.85E+13 sej

Biproducts (biodeisel, food products)
8.50E+15 g

%Renewability

13% Renewable

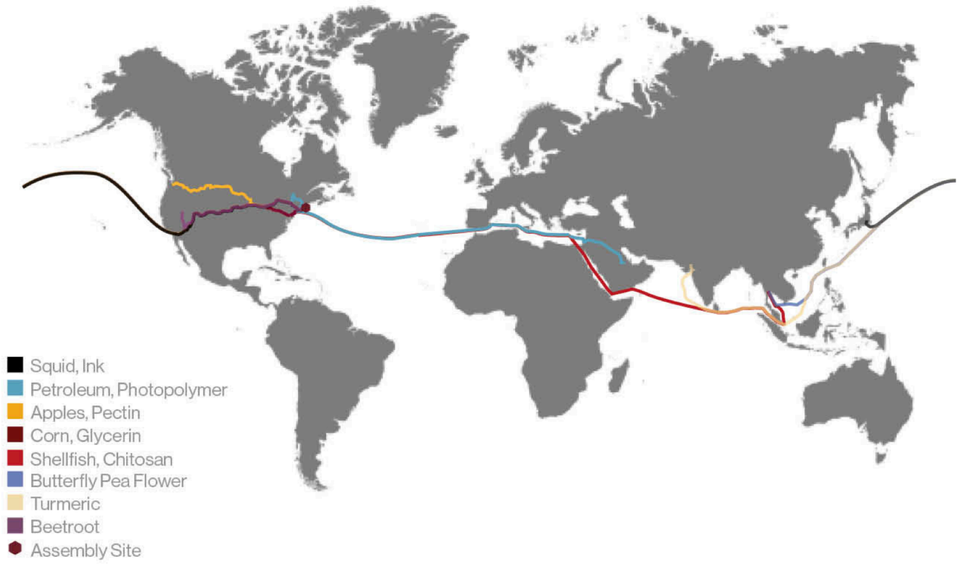
Renewable Inputs
4.38 E+14 sej

Yield
3.71 E+17 sej

13% Renewable

Territory

8.90 E+04 km



sej = solar emjoules

Discussion 1:

Is Aguahoja sustainable?

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Is Aguahoja sustainable?

1. **Can we break this *big* question into smaller questions?**
2. **What metrics do we need in order to answer those questions?**
3. **What other information do we need?**

(2 min) think about this on your own.

Discussion 1:

Is Aguahoja sustainable?

1. **Can we break this *big* question into smaller questions?**
2. **What metrics do we need in order to answer those questions?**
3. **What other information do we need?**

(3 min) discuss this in groups.

Studio 1:

What product / system / policy will you study?

Studio 1:

What product / system / policy will you study?

1. **What is the design you chose?**
2. **What sustainability claims are being made? Are they implicit or explicit?**
3. **Where will you draw your system boundary (geological, temporal)?**

Assignment due 1/12:
Prepare a brief (5 min) presentation that answers the above questions.